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UNITED STATES CIVIL-SERVICE EXAMINATION

The United States Civil-Service Commission announces an open competitive examination for Junior Chemist.

Applications for junior chemist must be on file with the Civil-Service Commission at Washington, D. C., not later than March 24th. The date for assembling of competitors will be stated on their admission cards and will be about ten days after the close of receipt of applications.

The examination is to fill vacancies in the Federal classified service throughout the United States, including the Departmental Service at Washington, D. C., and the Forest Products Laboratory of the Forest Service at Madison, Wis.

The entrance salary in the District of Columbia is $1860 a year. After the probational period required by the civil-service act and rules, advancement in pay depends upon individual efficiency, increased usefulness, and the occurrence of vacancies in higher positions. For appointment outside of Washington, D. C., the salary will be approximately the same.

Optional subjects are advanced inorganic chemistry, analytical chemistry, organic chemistry, and physical chemistry.

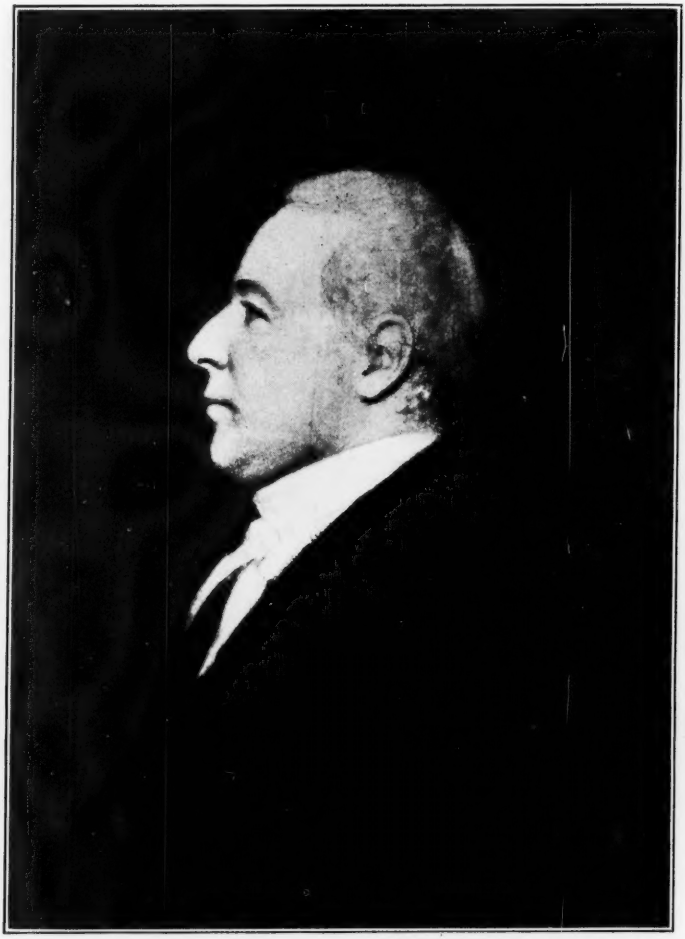
Competitors will be rated on general chemistry, elementary physics, and the optional subject selected.

Full information may be obtained from the United States Civil-Service Commission at Washington, D. C., or the secretary of the United States civil-service board of examiners at the post-office or customhouse in any city.

INSTITUTE OF CHEMISTRY

Following the successful inauguration of a Summer Institute of Chemistry at Pennsylvania State College last year, the American Chemical Society has announced a second session which is to be held on the campus of Northwestern University at Evanston, Illinois, July 23 to August 18, 1928. The general plan to be followed is similar to the one which proved to be so popular and inspiring last year. Living quarters for the chemists are to be provided in the commodious dormitory, Willard Hall, which will afford everyone an opportunity for personal acquaintance with the entire group. A typical day's program will include lectures upon topics of special interest to chemists, given by men who are able to speak with authority; conferences for discussion of live topics; recreation of various types; moving pictures presenting the best in the chemical industries; popular lectures of interest to chemists and laymen; social gatherings and trips to a great variety of interesting points within easy reach of Evanston. The delightful campus along the lake shore, the opportunity to hear and meet many of the leaders in chemistry of America and Europe, the privilege of side trips including music, art, education, the industries, the scenic beauty of the Great Lakes region, and the happy combination of summer vacation with educational privileges makes a most attractive program. Of special interest to teachers will be a series of discussions in chemical education which will be held throughout the four weeks' session.

Watch for detailed information concerning the program and plan to attend during the entire four weeks or as much of it as convenient. Because of the fact that this institute will be popular with both teachers and industrial chemists a large enrolment is certain. Reservations should be made as promptly as possible with the Executive Secretary, Charles D. Hurd, Institute of Chemistry, Evanston, Illinois.



Courtesy of N. Y. Historical Society

SAMUEL L. MITCHILL, M.D.
From Pastel by James Sharpless

EDITOR'S OUTLOOK

Science and Life

THE few casual remarks which we are moved to venture upon this topic are in part suggested by Professor A. W. Meyer's excellent essay entitled "Science and Conduct," in the *Scientific Monthly* for March. The discussion, both pro and con, concerning science as a factor in the evolution of a philosophy of life and as an element in liberal education is already an ancient one. It is doubtful whether anything entirely new remains to be said; certainly there is no hope of saying anything final. Yet certain time-worn errors and slanders continually spring up anew and, if there be anything in the advertiser's slogan that "Repetition Is Reputation," it is not amiss that we lay about us occasionally in an endeavor to mow down a few of these weeds ere they come to seed and multiply.

It is unfortunate perhaps that in the controversy which arises out of the attack on, and the defense of, science, there can be no middle ground from which an unprejudiced observer may deliver an unbiased judgment. The majority of the assailants of science are totally unqualified to judge whereof they speak. An acquaintance with science sufficient to enable one to discuss it and its philosophical implications intelligently is not acquired without lengthy and intensive study and training. In the process of achieving that training the individual automatically enrolls himself in the camp of the scientists.

In so far as the critics of science are ignorant, however, they are potentially weak. Their diatribes may have no less weight with the lay public for being fallacious but they are at least open to refutation. In the long run, science has more to fear from her indiscreet and over-zealous friends than from her avowed enemies. For some of the friends of science are as ignorant and as irresponsible in their statements as are many of her enemies.

There is also, among men who should know better, an occasional tendency to overstatement. Sometimes, perhaps, this weakness for exaggeration arises out of the rather prevalent opinion that it is always well to attempt somewhat more than one actually hopes to accomplish. As applied to some phases of human endeavor, that may be an excellent principle. It does not follow, however, that the weight of conviction carried in argument is in direct proportion to the extent of the claims made. More often is it true that an excellent case is irreparably damaged in the attempt to press a point too far. Nor does a lapse into this error necessarily denote any breach of sincerity. As Cardinal Newman has observed, some men are prone to center their attention upon the one subject which lies nearest their own interests, to magnify it out of

all true proportion, and to view everything else in the light of a real or fancied relationship thereto.

To abandon generalities, it seems to us that whereas we may rightly contend that science constitutes an essential factor in education, we should also freely admit—in fact we should specifically state—that it is not all-sufficient. No one with a real knowledge and appreciation of science will deny that it embraces a considerable element of the esthetic, to use that term in a broad and liberal sense. Yet, unless science has become a monomania with him, he will not contend that one may focus his attention upon the beauty and order of natural relationships to the exclusion of painting, sculpture, music, and the other arts, without great loss. Science, then, does not seek to combat the arts and humanities either by requiring of its devotees a cast of mind unfriendly to them, or by attempting to usurp their places. As Prof. Meyer points out, the only competition which may arise between science and these other elements of culture is that which involves the time factor. No matter what a man's specialty, it requires of him time and application which cannot, therefore, be applied to other interests. The conflict which arises between specialization and liberalization is general rather than specific.

It is sometimes charged that science is "materialistic" and again that scientists are mere collectors of facts. Both of these charges give evidence of profound ignorance on the part of their makers. It is true that the scientist works with material, but so must the graphic artist. And if the scientist be a collector of facts, so is the architect a collector of sticks and stones and bits of glass and metal. Perhaps science may lay upon her own supporters some of the responsibility for the creation of these superficial impressions. Scientific popularizers have emphasized disproportionately the material applications of science.

As touching science and ethics, we hear it said that science is non-moral, or sometimes that it is destructive of morality. If we conceive morality to be a thing of taboos and fetishes, science is certainly destructive. But there is no intrinsic demerit in destruction—one must consider the thing destroyed. After all, the difference between construction and destruction is a mere trick of language. Almost any idea may be phrased either positively or negatively. One cannot affirm a truth without in effect denying the contrary untruth or vice versa.

If we accept Prof. Meyer's working definition of morality as that which promotes the common good it is easy to show that science is not only a guide to right conduct but that it also supplies a motive. True, the motive is that of enlightened self-interest, but does not a great deal of the motive supplied by most religions reduce to the same thing in the last analysis? And once determined to pursue the course which promotes the common good, where can man look more hopefully than to science for direction along that course?

A CHEMIST OF A CENTURY AGO

COURTNEY R. HALL, ADELPHI COLLEGE, BROOKLYN, NEW YORK

In 1792 the Trustees of Columbia College appointed Doctor Samuel L. Mitchill professor of "chemistry, natural history, agriculture and the other arts depending thereon." The College possessed at that time but nine professors and thirty-nine students and had traversed but five years of its rejuvenated existence, its earlier history having been interrupted by the Revolution. In the last decade of the century New York City developed amazingly in population and general importance, but was still outdistanced by Philadelphia in sanitation, in financial prestige, and in cultural and scientific matters.

The man whom President Samuel Johnson and his advisers had appointed to fill the foregoing vacancy was of English Quaker stock, and had been born on Long Island, near Hempstead, in 1764. Two physicians, his maternal uncle, Doctor Latham, and the distinguished Doctor Samuel Bard, later Washington's official physician, prepared the boy for college. Just as the Revolution was ending he sailed for Edinburgh, there to come under the influence of what was perhaps the foremost group of medical scholars in Europe, among them the great chemist Joseph Black, the remarkable theorist William Cullen, and the scholarly Munros, who for three successive generations occupied the chair of anatomy. Graduating in 1786, Mitchill took a continental tour in the manner of the young graduate of that day; a tour destined to be extremely valuable to him in acquaintance and contact with brilliant leaders of science.

The years of Mitchill's apprenticeship were years of tremendous and lasting change not only in political and social directions, but in science as well. A long list of great chemical and physical discoveries was uncovered and the learned world was even then agog in its efforts to interpret them correctly. Specifically, in chemistry the anti-phlogistic school of Lavoisier and his French associates was endeavoring to lay the foundations of a really scientific chemistry, while equally able but less far-sighted chemists such as Priestley, Cavendish, and Scheele were endeavoring to bolster up the older phlogistic notions developed in Germany by Stahl and Becker. This condition existed despite the fact that the former gentlemen were themselves responsible for many of the discoveries which made the newer chemistry impossible.

The title of Mitchill's professorial chair implies correctly that he was not to give his entire attention to chemistry. He organized in the College a famous course in "natural history."[1] He began a wide and voluminous

[1] Mitchill, "Outline of Lectures in Natural History," *Med. Repos.*, **13**, 257–67 (1810), T. & J. Swords, New York.

correspondence with contemporary scientists,[2] relative to nearly every conceivable subject. His facilities for laboratory study of the natural sciences were practically nil, yet such were his enthusiasm and perseverance in collecting minerals, in recording data concerning tidal waves, evaporation and phosphorescence, in collecting and classifying new and strange varieties of fish, and in exchanging specimens and information with a multitude of correspondents in both Europe and America, as to cause widespread attention. He became, perhaps, the best-informed and most versatile man of science in the New World of his time. To his generation and especially to his New York friends, he was known as "The Doctor." "Tap the doctor at any time and he will flow," it was said. A least fifty learned societies claimed him as regular, honorary, or corresponding member.

Amazing as were the Doctor's activities in general scientific directions, we are more concerned here with his work as a chemist and his relationship to the general progress of that chemistry. Reference has already been made to the phlogistic explanation of combustion, which was being hotly contested by the newer French group of Lavoisier. When in 1794 the tired and care-worn Priestley arrived at New York from the oppressive religious air of Great Britain, he brought with him the germs of the American side of the phlogistic controversy. Received with acclaim at New York by De Witt Clinton, Mitchill, and other admirers, the great scientist refused all offers of speaking tours and lectureships and departed shortly to the vicinity of Philadelphia where occasional papers before the American Philosophical Society and valiant defenses of the doctrine of phlogiston filled up the remainder of his declining years.

Joseph Black, Mitchill's teacher at Edinburgh, had given up his belief in the older theory while the latter was in the University and so, logically enough, it fell to Mitchill's lot to be one of the first in this country to explain and interpret the newer chemistry. The College gained rapidly in numbers through the early years of the nineteenth century and hundreds of young men received their first ideas in chemistry in this way. Meanwhile, in Philadelphia, Benjamin Rush, an older pupil of Black's had also changed to the ranks of the "antis"[3] and influenced by his teaching a whole flock of Philadelphia chemists, among them Hare, Woodhouse, and Gibbs. Similarly, Benjamin Silliman, student of Woodhouse, was soon to take a professorship at Yale and there assist in spreading the new doctrines of chemistry. At Princeton there taught perhaps the most aggressive of all the anti-phlogistonists—John McLean.

[2] A large number of these letters appear in the *Medical Repository*, **1–21**, in Silliman's *American Journal of Science*, **1–20**, in the *American Mineralogical Journal*, **1–4**, and in many other scientific publications of the time; see bibliographical note at the end of this paper.

[3] Rush published in 1771 the first American fasciculus of chemistry.

The main importance of Mitchill as a chemist rests upon three major achievements, besides his work as an active-minded instructor of youth. In the first place, he established with Doctors Elihu Smith and Edward Miller the first so-called medical journal in the United States, a publication which appeared from 1797 until 1824. The *Medical Repository* was not merely a journal for the physician and surgeon but was even more concerned with the general progress of science. The fact that Priestley's famous pamphlet[4] had been published the year before the new venture of Mitchill and his editorial board gave them what they believed to be a great opportunity to be of service in reconciling the views of the two warring groups of chemists. Therefore, the *Medical Repository* became, during the first years of its existence, a medium for the statement of arguments for and against the doctrine of phlogiston. The affirmative is usually upheld by Priestley and occasionally by stray editorial remarks of Mitchill, who still claimed some value to adhere to the older theories. So Priestley, McLean, Woodhouse, Mitchill, Citizen Adet, and other able chemists discuss and argue in Mitchill's journal the meaning of experiments which all have performed.[5]

Thus Mitchill and his staff of editors rendered a unique service to science in this country by supplying a literary medium for new ideas and also endeavored to advance chemistry by encouraging the play of first-rate minds upon a controversy of so fundamental a character.

Another valuable service of Mitchill to chemical science was his publication in 1801 of a nomenclature of chemistry, designed, as he believed, to settle some of the doubtful points at issue, and to systematize what was fairly certain.[6] This small book of only forty-four pages consists of a large chart about two feet square and an explanation of the chart in the pages following. Down the left side occur the names of sixty-three "simple" substances with the "fashionable or proposed names" at the left and the synonyms or old names next to them. Horizontally across the chart are eight other double columns divided similarly to the above, these being the names of the compounds resulting from the combination and recombination of the original substances under varying conditions.

The numerous details of this chart are unimportant for us here, except to notice that instead of the "caloric" of the French he offered "anticroun" or the principle of repulsion; for their "azote" he suggested "septon" or the putrefactive principle; and for "hydrogene" he suggested phlogiston, because that term implied "blazing with fire" a more accurate description of that highly inflammable substance than the former, which

[4] Priestley, "Considerations on the Doctrine of Phlogiston," Dobson, Phila., **1796.**

[5] Mitchill to Priestley, *Med. Repos.*, **1,** 504–11. See also Mitchell's review of McLean's "Two Lectures on Combustion," *Ibid.*, 343.

[6] Mitchill, "Synopsis of Chemical Nomenclature and Arrangement," T. & J. Swords, New York, **1801.**

referred only to its "water-getting" qualities. In this regard Mitchill was in partial agreement with Cavendish, the discoverer of hydrogen, who could never see what it mattered which name was selected, so long as the properties of the gas were well understood.

It is quite amusing to notice in Mitchill's system such substances as potash, soda and ammoniac, as well as twenty-three acid bases, called "simple" with the additional explanation: "atoms either not known or associated in a manner not yet understood."[7] Yet the very admission is itself important as a milestone in the science, and though almost all of such an arrangement as Mitchill's is to a large degree obsolete, yet all scientists should applaud the ingenious and energetic efforts of the Doctor, bold, yet tentative, as evidencing the method of a truly scientific investigator.

Lastly, the extremely practical and helpful sides of our scientist's mental makeup led him to be always alert for new truth which could be successfully controlled for the material benefit of his fellows. As a founder of the American Mineralogical Society he was one of the first to apply chemical analysis to minerals; he was also of material aid to Secretary of the Navy Smith in detecting the defective saltpetre in Navy gunpowder.[8] He corresponded with as prominent agriculturists as Robert R. Livingston and the distinguished Sir John Sinclair, head of the British Board of Agriculture, regarding the efficacy of chemical fertilizers. There is some evidence to believe that Mitchill first isolated potassium phosphate; it is certain that he believed that it contained oxygen. According to Doctor Pascalis, friend and associate of Mitchill, the latter gave to Sir Humphry Davy hints which led to Davy's isolation of potassium and also led him to use a galvanic battery to break down alkaline earths.[9]

Space will not permit mention of Mitchill's application of his chemical theories to the treatment of disease, although that is, perhaps, the most interesting of all his extensive efforts to be of assistance to his contemporaries. The results or net importance to science of the work of a man of Mitchill's type are exceedingly hard to measure. In number of scientific specimens collected and in the quantity of actual experimental work done he would surely rank with the most versatile and energetic. But, unfortunately, those are not the measuring sticks by which we determine a scientist's worth. It is rather by the effectiveness of that labor and its influence upon his successors that we appraise him.

Most of Mitchill's really valuable work was in other fields of science than chemistry. In ichthyology, in botany, and in ethnology he made

[7] Mitchill, chart accompanying the Nomenclature.

[8] Mitchill to Secretary Smith, *Med. Repos.*, **6**, 426–8.

[9] F. Pascalis, "Eulogy on the Life and Character of the Honorable Samuel L. Mitchill," New York, **1831**. Similar opinions as to the indebtedness of Davy to Mitchill are to be found in the *Med. Repos.*, **7**, 82–3.

significant contributions which have not been so altered by the century's progress as were many of his ideas in chemistry. To the education of Americans in scientific directions he contributed vastly by his collection and publication of news and articles from all over the world, this powerful influence being vastly increased by his career as a teacher in Columbia College and by terms in both branches of our national Congress. It is well-nigh impossible to look through the files of any of the scientific periodicals published between 1795 and 1831 (the date of the Doctor's death) and not find some article from his facile pen. Specifically and finally, Doctor Mitchill seems to have rendered important service to the development of chemical education in the United States by, first, giving wide publicity to the great controversy going on in chemical circles; second, by attempting vainly, perhaps, but ingeniously to systematize the whole science in one chart; and third, by constantly experimenting and applying the results, whenever possible, to the alleviation of suffering or to the material well being of the race.

Bibliographical Note

No adequate biography of Mitchill has ever been written. Certain of his contemporaries, as Doctors Pascalis and Francis, have produced brief eulogistic memoirs shortly after his death. Mention of his main achievements may be found in Lamb's, Harper's, Appleton's, or Drake's biographical dictionaries, while more extensive sketches occur in Gross' "Lives of Eminent American Physicians" and in Kelly and Burrage's "American Medical Biographies." General American histories of the period in which Mitchill lived contain some references to him, the most favorable of which is that of Henry Adams. Likewise histories of medicine such as those of Garrison and Baas and Packard contain significant allusions to his work. E. F. Smith in his "Chemistry in America" and G. P. Merrill's "First Hundred Years of American Geology" give due credit to Mitchill as a pioneer scientist. But the main sources of information about the man are naturally in his own writings in the *Medical Repository*, **1–21**; the *New York Medical and Physical Journal;* Silliman's *American Journal of Science*, **1–20**; the *American Mineralogical Journal*, **1–4**; the *American Medical and Philosophical Register;* the *Annals of the New York Lyceum of Natural History;* the *Transactions of the New York Literary and Philosophical Society;* the *Transactions of the American Antiquarian Society;* the *Collections and Proceedings of the New York and Massachusetts Historical Societies*, and in many others. Mitchill also penned biographies of DeWitt Clinton, Jefferson, and Thomas A. Emmet, wrote a guide book of the City of New York and made public orations before many literary and patriotic societies.

CHEMICAL MICROSCOPY. II. ITS VALUE IN THE TRAINING OF CHEMISTS

E. M. CHAMOT AND C. W. MASON, CORNELL UNIVERSITY, ITHACA, NEW YORK

In recent years the question is not infrequently asked—"Why has not the young chemist been taught the fundamental principles of microscopy and their applications?" And we often hear wonder expressed by the older men in our chemical and allied industries, that such time and labor-saving methods are so commonly ignored and neglected.

It appears to be the general impression that chemical microscopy is new and novel. On the contrary it is very old. It was born when our science of chemistry was born out of alchemy and medicine, and has developed and expanded as the science of chemistry has developed and expanded.

The compound microscope was evolved simultaneously with Glauber's epoch-making observations upon crystallization phenomena. It is, therefore, not remarkable that this new instrument was seized upon with great avidity by all the workers in the field of chemistry who were able to do so, and with the new tool further progress was made in the comprehension of physico-chemical phenomena.

It is quite generally agreed that Marggraf in about the year 1745 was the first to make practical use of the microscope in the chemical laboratory in study of the sugar beet.

Some of this early work has stood the test of time but most of the recorded observations have been proved more or less incorrect owing to faulty observations, poor instruments, and improper methods.

When the iatro-chemists of this period sought to obtain a microscope "by hook or crook," it was under the belief that through the use of such an apparatus they could solve most, if not all, of their problems and that it would enable them to discover the causes underlying chemical combinations and decompositions and thus pave the way to a knowledge of life processes. They found instead that they were only the more confused. What had appeared quite simple to the naked eye became bewilderingly complex when viewed under the microscope; and where they had imagined only a single simple substance had been formed, they saw what they interpreted as many.

Try as they would, their problems apparently became more complex as the microscope was employed. Then, as now, many men believed that it was the microscope that would solve their problems—not the eye and brain back of it. Even today there are still workers in the field to whom will apply the vitriolic and cynical tirade of Raspail:

La plupart des micrographes modernes, s'adressant à un public dont ils ambitionnaient les suffrages ou à des juges dont ils sollicitaient les faveurs, mais également in-

capables de constater par eux-mêmes le mérite des observations, ces micrographes, dis-je, ne trouvaient pas de meilleure garantie à donner de l'exactitude des faits que de la richesse des microscopes dont ils s'etaient servis. "Nous avons observé cela avec le beau microscope d'Adams, avec l'excellent microscope de Selligue, avec l'incomparable microscope d'Amici" inscrivaient-ils en tête de leurs memoires; et tout le monde de se récrier sur l'incontestable découverte obtenue à l'aide d'aussi puissans instrumens. (1828).

In addition to insufficient training and lack of discriminating observation, improperly designed and constructed instruments led to many errors, for we are told:

Or, Guibourt était alors à son début dans l'emploi du microscope, et il ignorait que, pour rendre visibles à cet instrument des corps devenus trop transparens, il ne faut pas les éclairer d'un trop grand faisceau de lumière, ... Et d'abord, quant à son microscope, Guibourt annonce s'être servi de celui de Gabriel Pelletan que nous avions eu l'occasion de manier avant l'auteur. Or, ainsi que nous l'avons déjà dit (*Annal. des Sciences d'observ.*, II, 104 (1829)), ce microscope est une mauvaise noix de coco[1] qui avait appartenu à Haüy, et qui par les nouvelles modifications de ses lentilles, ne permet souvent par de voir des corps moins transparens que les tégumens de fécule. (Raspail, "Chimie Organique," Paris, **1833,** p. 18.)

Proof of faulty observations, of impossible hypotheses, of microscopic appearances so complex and confusing as to be not understandable with chemistry still in its swaddling clothes, eventually forced most investigators to cast aside the microscope in discouragement or in disgust and to revert to the more orthodox methods of mortar, test tube, and beaker. For these pioneers reasoned that if the microscope served only to confuse, then it were better relegated to the biologist or treated as a toy, a means for passing an amusing half-hour.

The writers have long preached against the folly of chemists who, before undertaking an analysis, fail to pick out, under the microscope, the different components seen in a sample. In mixtures, sampling under a microscope eventually saves time and labor and enables the analyst to ascertain the true composition of the different components, without having recourse to the calculation of "hypothetical combinations." Imagine our amusement and surprise to find that Raspail had anticipated us by about a hundred years. He writes with satirical humor:

Or, me disais-je, quand le chimiste broie, déchire, fait macérer ou boullir dans un menstrue un tronçon même minime de végétal ou d'animal, il doit nécessairement confondre et mélanger, dans le même menstrue, une foule de substances que la nature avait isolées dans des organes séparés. On dirait que le chimiste, fier de la puissance de son art, cherche à tout confondre pour se ménager le plaisir de tout démêler.

To avoid this Scylla and Charybdis of the analyst Raspail proposed microscopic sampling and microchemical analysis—

[1] In the slang of our day Raspail would have probably said "it is a lemon" instead of "a rotten coconut."

. . . j'invoquerai le secours des verres grossissans combinés en microscope. . . . . et je transporterai le laboratoire de chimie sur le porte-object.

We have quoted at length from Raspail's "Chimie Organique"[2] for this work is, we believe, the first attempt to present in a systematic manner microscopic information, methods, and tests *for the chemist.* He was also one of the first to suggest the observation of crystal habit under the microscope as a means for the identification of chemical compounds. His drawings of crystals are remarkably well done. It matters little that he was intolerant, cynical, and amazingly egotistical or that his reasoning and his experiments are often as incorrect as those of his contemporaries against whom he launched all the bitterness of a facile pen. The fact remains that he was a pioneer in a new realm of chemistry, though he was destined to attract few followers, and his efforts did not bear fruit until almost half a century later. This book, partly didactic, partly polemical, can in no sense be regarded as a discussion of microchemical methods alone (such as were then possible), but covered substantially the whole field of what the writers believe should be entitled chemical microscopy. As an historical document relating to the early art of applied microscopy its importance cannot be over-estimated.

In 1869 appeared Theodore G. Wormley's extraordinary work—"The Microchemistry of Poisons;"[3] remarkable not only for the thoroughness of the author in the discussion of the sensitivities of the reactions described, but even more so for the beauty and accuracy of the steel engravings illustrating the crystal forms of the reaction products proposed as tests.

In the preface to the first edition Dr. Wormley states that the book was projected in 1857 and that a prospectus was issued in 1861. Therefore, if we exclude Raspail's work, "The Microchemistry of Poisons" must be considered as the first thoroughly comprehensive discussion of microchemical tests.[4] Thus these tests have been before American

[2] Raspail, F. V., "Nouveau System de Chimie Organique, fondé sur des méthodes nouvelles d'observation," Paris, **1833.** This remarkable book written in prison at Versailles, is in reality an outline of Raspail's views on biochemistry as formulated from the experiments he describes. François Vincent Raspail was born in Carpentras in 1794 and died in 1878. He was a renowned theologian of his time, an enthusiastic chemist, and an uncompromising politician. Boulevard Raspail in the Latin Quarter of Paris was named in his honor.

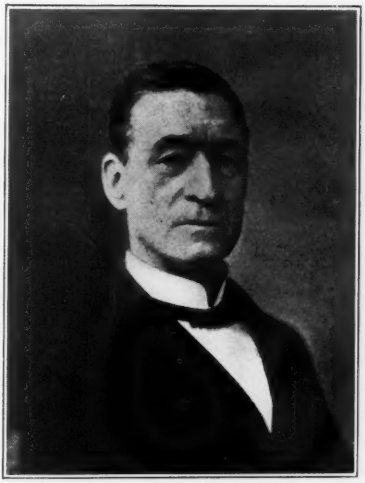
[3] Wormley, T. G., "The Microchemistry of Poisons," 1st ed., Wm. Wood and Co., New York, **1869.** 2nd ed., J. B. Lippincott Co., Philadelphia, **1885.**

[4] Wormley probably drew in part from Helwig, "Das Mikroskop in Toxicologie," Wiesbaden, **1864,** Mainz, **1865;** and from Erhard, "Die Giftige Alkaloide u. d. Ausmittelung auf Mikroskopischen Wege," Passau, **1866;** for he states that several works in German appeared before his book left the press in 1867. Wormley's work was, however, far more pretentious, thorough, and complete and its inception antedates these monographs. The idea was, therefore, original with Wormley.

chemists for over sixty years. His aim was thus stated:

> Among the more prominent objects of the present volume are to indicate the limit of the reactions of the different tests, ... and also to apply the microscope whenever practicable in determining the nature of the different precipitates, sublimates, etc. . . . . .Heretofore the microscope has received but little attention as an aid to chemical investigations, yet it is destined to very greatly extend our knowledge in this department of study.

Unfortunately, Wormley so completely submerged the microscopic tests in the extended discussion of legal chemistry, medical jurisprudence and the relative sensitivities of microchemical reactions (many of them not microscopic), that chemists were not convinced of their general utility and their reliability. Like Raspail he was more influenced by the science of medicine than by chemistry.[5]



DR. THEODORE G. WORMLEY, AUTHOR OF "THE MICROCHEMISTRY OF POISONS:" THE FIRST SYSTEMATIC TREATISE ON THE APPLICATIONS OF MICROSCOPIC QUALITATIVE ANALYSIS*

* The authors are indebted to the courtesy of Dr. Edgar F. Smith of the University of Pennsylvania for the loan of the fine portrait from which this copy was made.

His failure to arouse interest in this new system of qualitative analysis was further due to his neglect to give specific directions for the performance of the various microscopic identity tests, and to point out that similar methods could be devised for the detection of both elements and compounds, and that in routine analysis such tests would be time- and labor-saving. Most of the writers in this field, even in more recent times, have made a similar mistake.

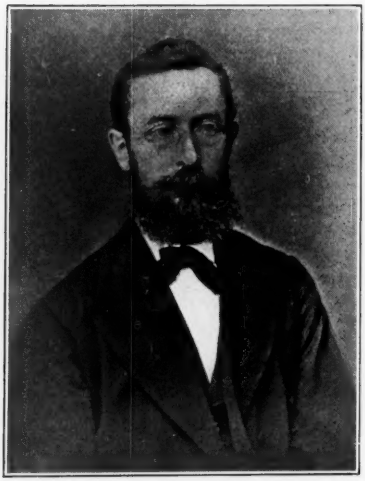
No further advances of importance were recorded for some ten years; there then appeared the publications of a veritable galaxy of workers in this field. Those whose publications contributed most were: Rosenbusch (1873), mineralogist and petrographer; Planeth (1873), botanist; Streng (1876), mineralogist and petrographer; Boricky (1877), petrographer; Poulsen (1880), botanist; Lehmann (1881), physicist; Haushofer (1885),

[5] At the time of the first edition, Dr. Wormley was Professor of Chemistry and Toxicology in Starling Medical College and of Natural Sciences in Capital University, Columbus, Ohio. He later became Professor of Chemistry and Toxicology in the Medical Department of the University of Pennsylvania, Philadelphia, Pa.

mineralogist; Klément and Renard (1885); H. Behrens (1881–94), geologist and chemist; Zimmermann (1892), botanist; Schoorl (1909), chemist.

Space will not permit us to discuss what each one of these men contributed nor to weigh the relative values of their contributions. Two of the men, however, need more than mere mention. It was Rosenbusch who developed and systematized optical crystallography and its applications to the identification of minerals in rock sections and by his admirable presentation[6] made these methods more generally known and available, but it was Behrens who was the real founder of our present science of microscopic chemical analysis.

Knowing that chemists were not trained in optical crystallography Behrens presented microchemical analysis from a very different angle. He was led to this because, he states,[7]



PROFESSOR H. BEHRENS, THE REAL FOUNDER OF OUR MODERN METHODS OF MICROSCOPIC CHEMICAL ANALYSIS

> It seems to me that the reserved attitude of chemists towards microchemical analysis may have been caused, in the first place, by the belief that microchemical tests cannot be of any use without a long apprenticeship in the use of the microscope and that they are therefore apt to lead the observer into error. . . . . If the microchemical tests had been worked out by chemists instead of by geologists, the form of the crystals or the angles of their faces would certainly never have held the first place among the characteristics employed.

It is a real misfortune that he (himself a "geologist") should have discarded so completely all determinations of crystallographic constants, and that he purposely neglected to point out that by a combination of chemical tests and the measurement of certain optic properties it is possible not only to identify anions and cations but to determine the way in which they are combined and the true formulas of the salts. Kley in his revision[8] of Behrens' works has partially remedied this omission and has thus greatly extended the usefulness of the Behrens' system.

[6] Rosenbusch, H., "Mikroskopische Physiographie der petrographisch wichtigen Mineralien," 1st ed., **1873,** Stuttgart.

[7] Behrens, H., "A Manual of Microchemical Analysis," Macmillan, London, **1894.**

[8] Behrens-Kley, "Mikrochemische Analyse," Leopold Voss, Leipzig, **1915.** Behrens-Kley, "Organische Mikrochemische Analyse," Leopold Voss, Leipzig, **1922.**

Behrens' manual made microscopic qualitative analysis far more serviceable than it previously had been, but he failed to give his system a sufficiently broad chemical basis to enable the tyro to work intelligently. He also failed to give adequate directions relative to the specific manner in which the reagents should be applied and why.

It is quite evident that he realized that microchemical analysis is not so simple and so easy as it appears from the text for he states:

> I venture to say that, *by assiduous study*,[9] microchemical analysis will be developed into a system that will rival blowpipe analysis as regards its rapidity and its unassuming character with regard to space and laboratory appliances, and in many instances surpass blowpipe analysis in the variety and delicacy of its tests.

But so thorough was Behrens' compilation that since his death in 1905 but few new tests of real value have been proposed for the detection of the 59 elements he discussed in his Manual of 1894.

BEHRENS' LABORATORY OF MICROCHEMISTRY. POLYTECHNIC SCHOOL OF DELFT. EXTERIOR AS IT WAS WHEN THE LABORATORY WAS FIRST OPENED IN 1898

The first really important additions to Behrens' work were made by Schoorl.[10] Since this time much work has been done by many investigators, and microscopic chemical analysis has been broadened and made more dependable and now is applicable to the detection of both anions and cations and also to the identification of organic compounds. Behrens' name will always occupy a prominent place in the chemists' Roll of Fame. He will be remembered as are Platner, Fresenius, Mohr, and Hempel, for he opened up and developed a special field of chemical analysis. Moreover, he established the first laboratory[11] devoted exclusively to instruction in microchemistry. Unfortunately, he never realized his dream of a great center for the study of the science he worked

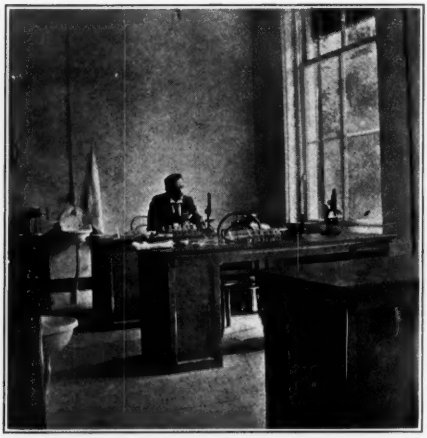
[9] The italics are ours.

[10] Schoorl, N., "Beiträge z. Mikrochemischen Analyse," C. W. Kreidel, Weisbaden, 1909. First published as a series of papers in *Zeit. anal. chem.*, 1907–9. Prof. Analytical Chemistry, University of Utrecht.

[11] Completed in 1898. Polytechnische School, Delft.

so hard to establish, for he died seven years after his laboratory was opened for work.

Of contemporary chemists now interested in microscopic chemical analysis, it is our opinion that three men deserve especial mention for their contributions and their efforts to keep microscopic methods before the chemical public. These men are Friedrich Emich,[12] P. D. C. Kley,[13] and O. Denigès.[14] Of the three, Emich has treated the subject in the broadest manner, laying due weight upon its educational features.



BEHRENS' LABORATORY OF MICROCHEMISTRY. PROBABLY THE FIRST LABORATORY TO BE DEVOTED EXCLUSIVELY TO INSTRUCTION IN MICROCHEMISTRY; AS IT APPEARED WHEN FIRST OPENED FOR WORK IN 1898. PROFESSOR KLEY, WHO SUCCEEDED TO THE CHAIR OF MICROCHEMISTRY UPON THE DEATH OF BEHRENS IN 1905, SITS AT THE WORK TABLE IN THE BACKGROUND

We have gone into the evolution of microchemistry and the development of chemical microscopy with so much detail because by so doing we hope to correct the almost universal misconception that microscopic chemical analysis is a new analytical procedure. Furthermore, this historical background will aid in making clear some of the reasons for the lack of interest of chemists in a most fascinating, instructive, and useful branch of chemistry.

The reader will have noted that until about the beginning of the present century not one of the pioneers in the field was a full-fledged chemist by inclination.

They were "geologists," botanists, adepts in medicine or medical jurisprudence. Each one developed tests and methods specifically adapted to the peculiar problems of his particular science. The botanists proposed tests for the detection of the elements in plant cells, the mineralogists for the analysis of specific minerals, the toxicologist for the identification of traces of poisons in material isolated in a more or less pure state from organic matter. All of these investigators had in mind the sensitivity of the tests and ability to deal with minute amounts of material. When

[12] Professor of Inorganic Chemistry, Technische Hochschule of Graz.

[13] Professor of Microchemistry, Technical University of Delft.

[14] Professor of Biochemistry, University of Bordeaux.

the analytical chemists attempted to apply these reactions to the materials submitted to them for examination they found the descriptions of the tests incomplete, the interferences overlooked, and the material in hand too complex to enable them to interpret the results they obtained in the light of the meager information given by the originators of the tests. They saw at once that in order to employ microscopic tests they must first work up the whole field, and since emphasis had been laid upon the sensitivity of the reactions, they naturally decided that it was not worthwhile spending much time upon them, for it was not often that they were called upon to have recourse to such refined methods. They failed to read between the lines and to perceive that the time- and labor-saving feature would well repay them for their study. All these causes have militated against the more general use of the microscope in the chemical laboratory, and because "microchemical" tests have not aroused the interest of the average analyst it follows that the more extensive methods of chemical microscopy have been disregarded.

To be more widely used these methods must be taught. If they are to be taught there must be incorporated into them something more than their mere practicability. It is this phase that has been overlooked by our writers, and because of this educators have shown little interest in developing courses in chemical microscopy.

The writers believe that chemical microscopy should be regarded as a legitimate discipline in our chemical curricula, using the term discipline in its broad sense as used in pedagogy. Therefore, they have welcomed the opportunity afforded by the invitation of the Editor here to present their views relative to this completely ignored aspect of courses in microscopic analysis.

In our first paper[15] we tried to make clear the educational value of crystallization experiments as an introduction to metallography, and we pointed out that such a series of experiments may be employed to great advantage in teaching physical chemistry; to this latter phase we shall have occasion to return in a subsequent paper.

Microscopic studies of chemical phenomena give real "close-ups" of the processes involved, and work in microscopic qualitative analysis tends to focus attention upon the reactions taking place and the products formed, rather than on the mere "positive or negative" character of a test. In a sense, it may be regarded as a course in micro-inorganic preparations, for many type reactions and classic relationships are examined in a rather intensive way. The rapidity of micro methods, besides permitting a large number of reactions to be covered, prevents their *chemistry* being obscured by time-consuming manipulations. For instance, it is the work of a few moments to study the behavior of a series of elements in response

[15] THIS JOURNAL, **5**, 9–24 (Jan., 1928).

to a given reagent and, consequently, the student's interest is maintained throughout, instead of being allowed to fail as it often will when he is obliged to await results from which he cannot draw conclusions until all the facts have been obtained.

Such comparative studies are particularly useful in connection with families of the elements according to the Periodic Classification, and serve to point out some of the most beautiful relationships in the whole field of chemistry. The analogous behavior of potassium, rubidium, cesium, and ammonium is shown by the high degree of similarity of their crystalline compounds such as chloroplatinates, perchlorates, and alums, all of which are utilized in microscopic qualitative analysis. The gradation of solubilities with atomic weight is exemplified as the student compares the limits of precipitation of Cs_2PtCl_6 or $CsAl(SO_4)_2.12H_2O$ with those of the corresponding rubidium and potassium compounds.

The fact that sodium does not strictly belong with the other members of the alkali family is brought out by the much higher solubility and entirely different crystal form of Na_2PtCl_6.

The crystallographic similarity and interchangeability of chemically similar elements in compounds, embodied in the principle of "isomorphism," was used by Mitscherlich in assigning the atomic weight of selenium, and by Dumas in the case of silver. It has aided greatly in the formulation of the periodic classification of the elements, although it is all too little emphasized at present, but in "microchemical" analysis it is constantly employed. A most striking method of illustrating the chemical similarity of manganese and chlorine, both of which appear in the same group, is afforded by a study of the salts $KClO_4$ and $KMnO_4$, which are isomorphous and form solid solutions in all proportions. Ag_2SO_4 and Ag_2CrO_4 constitute another example of isomorphism which is the basis of micro tests for Ag, Cr, CrO_4, and SO_4.

The mutual replaceability of bivalent metals, so well known to mineralogists in the "femic" minerals, is manifest in the series of triple uranyl acetates used in the detection of sodium, in which Mg, Zn, Cd, Mn, Fe, Co, Cu, and Ni form crystallographically identical salts.

Although many of the familiar reactions of qualitative and quantitative analysis have been borrowed by the "micro-chemist," these have a fuller significance when studied by themselves instead of as a part of an analytical scheme, and in microscopic qualitative analysis they are examined from many angles. Most of our characteristic tests for metals may be reversed for use in the recognition of acids; *e. g.*, $MgNH_4PO_4.6H_2O$ is the crystalline precipitate upon which depend the identifications of magnesium, ammonium, and phosphate, any two of these ions being used to test for the third one. The double mercuric thiocyanates with copper, zinc, or cobalt, the triple nitrites of potassium, lead,

and nickel or copper, and many other compounds are utilized in a similar manner.

The ordinary reactions of microscopic qualitative analysis include many which are not commonly illustrated experimentally in elementary courses, but which are easily carried out on a micro scale. Oxidation of bivalent manganese to permanganate by sodium bismuthate, ammonium persulfate, or by fusion with sodium carbonate and potassium nitrate; oxidation of trivalent chromium to chromate by a similar fusion, or by potassium chlorate; recrystallizations from concentrated H_2SO_4, HCl, and NH_4OH; the separation of metals from solution by application of the electropotential series; the reduction of mercury compounds by heating with sodium carbonate; the use of "nitron" for the detection of nitrates and dimethylglyoxime for nickel—these are only a few of the many interesting reactions which are studied.

Double and triple salts figure frequently in microscopic qualitative tests, and after a student has compared their distinctive crystal habit with the salts from which they are formed, he has a very real concept of their definitely individual nature. He also becomes familiar with the profound modifications of crystal habit often effected by small quantities of other substances. Complex ions also become realities after he has tested for chromium in a solution (often strongly colored) in which it is in the form of a complex, or when he has applied a cyanide test to a solution of a ferricyanide.

Such an array of reactions, some of them used only in micro tests, would hardly be justified if it were not for the fact that their very novelty makes the student examine them from more than one angle, and encourages him to look into the chemistry which they exemplify. Not only is it necessary to study the specific reactions, but the various conditions which affect them and the possible interferences with their use in analysis must be considered, so that a general review of the chemical properties of the common metals and acids is involved.

This re-examination of fundamental inorganic chemical principles and properties the authors believe to be invaluable, particularly for seniors and graduate students. The general tendency to dismiss all studies which have been passed is actively combated by the continual emphasis on relationships and differences of various elements, on the physical chemistry of their reactions, and on the crystallographic properties of their salts; and the realization is forced upon the student that there is no dividing line between "inorganic" and "organic" chemistry.

In working on "unknowns" a student does not follow a cut-and-dried scheme of analysis, but plans his attack on the basis of the properties of the substance as he ascertains them, and this results in his continually making use of reference works in inorganic and analytical chemistry, and of tables of properties.

Our students are outspoken in their recognition of the value of all this as a training in chemistry, but they perhaps do not appreciate another phase of such a course, which is fully as important—namely, exercise in logical reasoning, and deductions from facts which they have *learned* but may not yet really *know*. Insistence that they shall *prove* the identity of their unknowns, and that conclusions based on chemical reactions must always be consistent with the physical properties of the substances concerned, offer many pitfalls to the "guessers" but call for a real *working* knowledge of chemistry, and often a certain ingenuity in its application.

The educational value of a course in microscopic qualitative analysis may further be urged on the grounds of the vivid appreciation it gives of the phenomena of precipitation, super-saturation, digestion, and recrystallization, as these are observed under the microscope.

One might expatiate upon the rapidity and elegance of manipulative technic that is involved in a micro-Gutzeit test for arsenic, or a chromyl chloride test for chlorine. Stress might be placed upon the small amounts of material that may be dealt with, and the negligible cost of even the most expensive reagents when used on a micro scale.

The authors believe, however, that these points are more or less self-evident, and have chosen to direct attention to the purely chemical aspects of the course, not simply for its educational value in inorganic chemistry, but because, conversely, it is only through a thorough and diversified knowledge of this field that the micro analyst can hope to deal with the variety of problems which confront him.

Out of "microchemical" analysis there has been developed by the chemist a far broader field of applied microscopy. This newer art may be best designated as chemical microscopy, for it embraces chemistry, microscopy, and physics. Through it the student becomes familiar with the construction and uses of microscopes and their accessories and their diverse applications. He learns how to select and to test the proper equipment for the solution of special as well as general problems.

Because much of the material studied does not come within the experience of the average student in the usual courses in chemistry, his horizon is extended, his knowledge augmented, and his powers of observation rendered more acute and trustworthy.

In our next article we shall discuss why and how a course in chemical microscopy was developed at Cornell University and of what educational and of what practical value it has proved.

Practice without science is a boat without a rudder.—LEONARDO DI VINCI

EMERSON AND CHEMISTRY.* PART I

CHARLES ALBERT BROWNE, BUREAU OF CHEMISTRY AND SOILS, WASHINGTON, D. C.

"Every law of chemistry has some analogon in the soul."—Emerson.

Emerson as a Student and Teacher of Chemistry

That Ralph Waldo Emerson, poet, essayist, and transcendental philosopher, should have been interested in so material a science as chemistry may appear anomalous. Yet the pages of his works are filled with references to the elements, compounds, operations and applications of chemistry and to the names of great chemists. If Emerson had not followed literature as a profession, he might have become a scientist. Very early as a child he began to observe the properties of substances and to make simple experiments. Towards the end of his life he wrote:

> When a boy I used to go to the wharves, and pick up shells out of the sand which vessels had brought as ballast, and also plenty of stones, gypsum, which I discovered would be luminous when I rubbed two bits together in a dark closet, to my great wonder; and I do not know why luminous to this day. (Jour. X, 381.)[1]

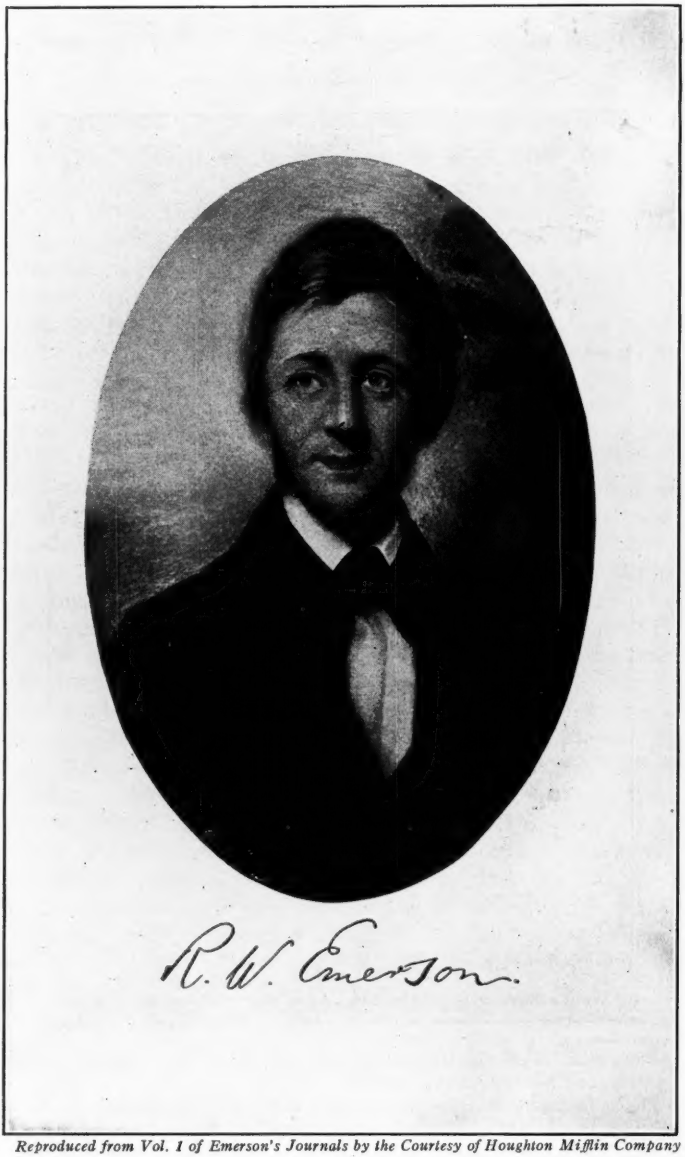
The magnetizing of his penknife until it would hold a needle was another of these boyhood experiments. It was thus very early in life that he became interested in a phenomenon to which, as a symbol of all unseen forces, whether material or spiritual, he always attached a great significance.

When Emerson entered Harvard College in 1817, Dr. John Gorham had only recently been appointed to the professorship of chemistry. The chemical courses which Gorham offered to the medical students and undergraduates of Harvard were typical of the period and consisted largely of lectures with but little attention to practical laboratory instruction. It was to supplement these lectures that Gorham in 1819 published his "Elements of Chemical Science," in two volumes—"a treasure in the chemical literature of America," according to the verdict of Professor Edgar F. Smith in his recent delightful volume upon "Old Chemistries." Gorham's new book was naturally a subject of conversation in the college circles of Harvard, and, having been written in a simple interesting style, made a strong appeal to the student readers. It came inevitably to the attention of young Emerson, who made in his journal for November 10, 1820, the following entry:

> Young Waldo, when in your thick-coming whims, you feel an itching to *engrave*, take a piece of glass and cover it with a thin film of wax or isinglass and trace the pro-

* Paper read before the Division of History of Chemistry at the Detroit Meeting of the American Chemical Society, September 8, 1927.

[1] The bibliographic references in this paper indicate volume and page in the Works (12 volumes) and Journals (10 volumes) of Emerson, Centenary Edition, published by Houghton Mifflin Co., Boston and New York, to whom acknowledgment is due for permission to publish the extracts which are quoted.



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RALPH WALDO EMERSON (1803–1882), FROM AN EARLY MINIATURE

posed figure with a steel point. Place this over a vessel containing a mixture of powdered fluor-spar, and sulphuric acid gently heated. The acid gas coming into contact with the uncovered parts of the glass combines with and removes the silex, as well probably as the alkali with which it is united, and lines more or less deep are thus formed—according to Gorham's Chemistry (Article Silicon), page 265, volume one. (Jour. I, 71–2.)

There were also other chemistries which attracted the attention of the young student. In a list of books marked "inquirenda," which Emerson jotted down in his eighteenth year, we find among works upon history, biography, travel, philosophy, poetry, and general literature, the item, Davy's Chemistry. This is the first mention of a chemist whom Emerson always revered and references to Davy's name are frequent in the subsequent pages of his journal. Dr. Black is another name referred to at this time by Emerson, who calls attention to a fine eulogy of this chemist in the third volume of the *Edinburgh Review*. He also mentions the name of Priestley, not, however, for his chemical views but for certain of his philosophic ideas.

Immediately after graduating from Harvard, Emerson became associated for two years with his brother William, who conducted a private school for girls in Boston. Among the studies which he taught at this institution was an elementary course in chemistry, supplemented possibly with demonstrations of some of the simpler experiments that he had learned from Gorham's textbook. Although only a boy of nineteen there is reason to suppose that his native charm of presentation made the subject interesting. Emerson himself, however, had serious misgivings upon this point and, when meeting a group of his old pupils over forty years later, has this to say with respect to his early teaching:

> I was at that very time already writing every night in my chamber my first thoughts on morals and the beautiful laws of Compensation and of individual genius, which to observe and illustrate have given sweetness to my life. I am afraid no hint of this ever came into the school, where we clung to the safe and cold details of languages, geography, arithmetic and chemistry. (Works II, 395–6.)

In 1823 Emerson began to study for the ministry, although he still continued to do some teaching at schools in Chelmsford and Cambridge. He prepared himself for his courses of instruction by doing some general reading in chemistry and the other sciences. He seems also to have recommended books upon these subjects to his pupils. In some suggestions upon reading, written somewhat later to a girl cousin of his first wife, Emerson recommends among works upon astronomy, ornithology, and other branches of natural history, the "School Conversations on Chemistry," which was no doubt one of the many editions or imitations of the famous "Conversations" by Mrs. Marcet.

Emerson commenced about this time to read books upon science with

increasing interest and appreciation, for it began more and more to be impressed upon him that the laws which govern the combinations and transformations of matter have also a moral and spiritual significance. The search for the analogs of the material in the realm of the immaterial was now begun and zealously continued for the remainder of his life. This was a natural consequence of the transcendental philosophy of Schelling, of which Emerson became a leading advocate, and which involved the transcending or passing beyond the objects of sense perception to the higher spiritual realities. Aristotle, over two thousand years before, had indicated this double relationship by the terms physics and metaphysics and upon the analogy of the latter word Emerson once coined the word *metachemistry*. His general attitude in this respect is well indicated by a remark which he made in later life:

> All the new facts of science are not only interesting for themselves, but their best value is the rare effect on the mind, the electric shock; each new law of Nature speaks to a related fact in our thought: for every law of Chemistry has some analogon in the soul, and however skilful the chemist may be, and how muchsoever he may push and multiply his researches, he is a superficial trifler in the presence of the student who sees the strict analogy of the experiment to the laws of thought and of morals. (Jour. X, 422.)

Emerson's Relations with Chemists at Home and Abroad

The death of Emerson's young wife in 1832 was followed soon afterward by his resignation from the pastorate of the Second Church in Boston. The immediate reaction of these critical happenings was his making a seven months' trip to Europe during which he visited Malta, Sicily, Italy, Switzerland, France, and England. He formed many new friendships along the way and met many writers and scientists of whose work he had previously read. He indicated the purpose of these new human contacts in one of his characteristic comparisons:

> The chemist experiments upon his new salt by trying its affinity to all the various substances he can command, arbitrarily selected, and thereby discloses the most wonderful properties in his subject. And I bring myself to sea, to Malta, to Italy, to find new affinities between me and my fellow men. (Jour. III, 28.)

It will be of interest to mention some of the scientific contacts which Emerson made during his first European journey. In the notes of his Malta trip we find the following item:

> Called upon Mrs. Davy, a very agreeable woman. Dr. Davy (brother to Sir Humphry) is given to chemical pursuits. Much younger than I expected and of simple manners. (Jour. III, 36.)

This was Dr. John Davy who, in the leisure moments of his foreign service on the Medical Staff of the British Army, had completed in Malta, just previous to Emerson's visit, his well-known "Memoirs of the Life of Sir Humphry Davy."

Emerson, on his journey northward through Florence, made the following note in his diary for May 10, 1833:

> Visited Professor Amici and saw his optical instruments. He is reputed the maker of the best microscopes in Europe. He has also made a telescope for Herschel in London. He has a microscope whose magnifying power is 6000 diameters, or 36,000,000 superficies. To instruments of this enormous power he applies the camera lucida and then draws the outline of the object with pencil. His experiments upon polarized light are beautiful. (Jour. III, 111.)

Of this visit to Amici, Dr. Oliver Wendell Holmes was led to remark: "Emerson hardly knew his privilege; he may have been the first American to look through an immersion lens with the famous Modena Professor."

A month later in Paris Emerson records other pleasant experiences:

> I have been to the Sorbonne, where the first scientific men in France lecture at stated hours every day, and the doors are open to all. I have heard Jouffroy, Thénard and Gay-Lussac. (Jour. III, 156.)

And again a few weeks later, on July 15th:

> I went to the Mazarin Library and Mr. Warden kindly introduced me to the *séance* of the Class of Science in the Institute, and pointed out to me the conspicuous men. I saw Biot, Arago, Gay-Lussac, Jouffroy and others. Several memoirs were read, and some debate ensued thereon. (Jour. III, 170.)

In commenting afterward upon the wealth of intellectual opportunities which awaited him in Paris during this visit, Emerson made the following remark in his delightful reminiscent way:

> We remember, when arriving in Paris, we crossed the river on a brilliant morning, and at the book-shop of Papinot, in the Rue de Sorbonne, at the gates of the University, purchased for two sous a Programme, which announced that every Monday we might attend the lecture of Dumas on Chemistry at noon. * * * For two magical sous more, we bought the Programme of the College Royal de France, on which we still read with admiring memory, that every Monday, Silvestre de Sacy lectures on the Persian Language; and other hours, Lecroix on the Integral Mathematics; Biot on Physics; Elie de Beaumont on Natural History; Thénard on Chemistry; and so on to the end of the week. On the same wonderful tickets, as if royal munificence had not yet sufficed, we learned that at the Museum of Natural History, at the Garden of Plants, three days in the week, Brongniart would teach Vegetable Physiology and Gay-Lussac Chemistry. With joy we read these splendid news in the Café Procope, and straightway joined the troop of students of all nations, kindreds and tongues, whom this great institution drew together to listen to the first *Savants* of the world without fee or reward. (Works XII, 475–6.)

Just previous to sailing home from England, Emerson made the acquaintance in Liverpool of his distinguished fellow countryman, Jacob Perkins. This man, who was equally renowned as a scientist and inventor, was born at Newburyport, Massachusetts, in 1766. He was the first to demonstrate the compressibility of water by means of the piezometer which he invented for this purpose; he constructed instruments

for measuring the depth of the sea and also perfected a method for decarbonizing and hardening steel which revolutionized the processes of printing bank notes and engravings. Perkins also developed the high-pressure steam engine and made many other useful inventions. He spent his last years in England where his scientific work was more appreciated than in America. Emerson makes several references to his conversations with Perkins. In his Journal for September 1st we read:

> Here at my hotel, the Star and Garter, Paradise Street, I have found Jacob Perkins the inventor of so many improvements in steam engines. He has been illuminating me upon the science of heat. (Jour. III, 187.)

And again on September 3rd we find the following notes:

> Mr. Perkins recited with glee his victory over one of the directors of the Manchester road. Mr. Perkins showed that his engine had beat the Sun (Stephenson's) all last week, doing more work with less coke.
>
> He says that he confidently expects the time when the ocean will be navigated by merchantmen by *steam* as the most economical means, but there is a great deal to be done first; that now very little advantage is taken of the *expansion* of steam, its most important property. (Jour. III, 191.)

Like many other inventors Perkins failed to derive much wealth from his patents. He remarked to Emerson that he had succeeded in everything, which he undertook, except making money.

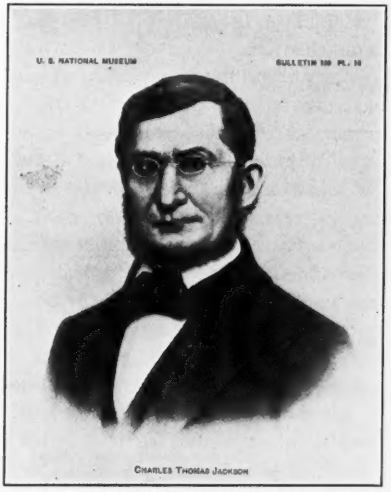
After returning to America Emerson began his career as a public lecturer. In 1834 he bought the place at Concord where he was to spend the remainder of his life and in the following year married Miss Lydia Jackson. The union, which was a most happy one, had important consequences for the future scientific interests of Emerson, in that it brought him into close companionship with Mrs. Emerson's brother—Dr. Charles T. Jackson—a man of wonderful versatility who won equal distinction in the fields of chemistry, geology, and medicine. His contributions to the literature of these sciences numbered over four hundred papers. Emerson states that "Dr. Jackson was born to chemistry and his minerals." (Jour. VI, 471.) He was the first to make a chemical study of sorghum in the United States and was among the earliest to call attention to the vast economic possibilities of cottonseed. He was the first to observe the occurrence of tellurium and selenium in America and was also the earliest to detect the presence of chlorine in meteorites. He made the first geological and agricultural surveys of Maine, Rhode Island, and New Hampshire, holding the position of State Geologist in all three of these states, for which he made reports and collections. He made also extensive explorations of the mineral deposits of the Lake Superior region upon which he wrote a scientific report for the U. S. Government in 1849.

According to the testimony of those who knew him Dr. Jackson was a man of titanic energy, whose fertile mind was continually overflowing

with ideas which he himself, owing to the demands of his numerous occupations, could never carry out. He is said to have suggested the method of the electric telegraph to Morse and he imparted the idea of using ether as an anesthetic agent to various pupils and friends several years before the matter was subjected to a practical demonstration.

Jackson seems to have begun his investigations upon anesthetics with nitrous oxide, but experiments upon himself and others convinced him that this gas did not prevent the sensation of pain. Emerson, in his journal for November, 1840, made the following humorous entry:

> In Boston at Dr. Jackson's I saw five or six persons take the nitrous oxide gas. It looked very much as if the bladder was full of opinions. (Jour. V, 490.)



From Bulletin 109 of the U. S. National Museum

CHARLES THOMAS JACKSON (1805–1880), CHEMIST, GEOLOGIST, AND PHYSICIAN

In 1837 Jackson first noted that the breathing of ether vapor alleviated the pain which resulted from the accidental inhalation of chlorine, and began using it for this purpose in his laboratory from that time on. Early in 1842 he was himself nearly suffocated by chlorine and sought alleviation from the pain in his throat by the inhalation of ether. Taking more than the ordinary quantity he noticed a gradual loss of sensation and finally lapsed into complete unconsciousness. Upon recovering from this experience it occurred to him that ether might be used for the prevention of pain in surgery. He communicated his experience and conclusions to various chemists and physicians but his geological and laboratory work prevented him from having the use of ether in surgery subjected immediately to a practical test.

Finally, in 1846 Jackson suggested to his pupil, William T. G. Morton, who was a dentist, that he employ ether for the painless extraction of teeth. This having proved successful, arrangements were made for a demonstration of the use of ether in surgery at the Massachusetts General Hospital in Boston. The demonstration, at which Morton administered the anesthetic, was a complete success and as a result of the publicity which resulted from the event the use of ether in surgery soon became general in all parts of the world.

It has happened in the case of many great discoveries that disputes as to honor or priority almost immediately arise, and the discovery of ether anesthesia was no exception to this rule. A bitter controversy at once arose between the friends of Jackson and Morton as to who deserved the credit for the discovery. The case was very similar to the more recent discussion as to whether Professor Ira Remsen or his pupil Dr. Fahlberg discovered saccharin. Fahlberg made saccharin according to the suggestion of Remsen, just as Morton administered ether at the suggestion of Jackson. The conclusion of the French Academy of Arts and Sciences, to whom the case had been submitted for an opinion, was that Jackson originated the idea but that Morton deserved credit for the demonstration.

Many imprudent and reprehensible things were said and done by the participants on both sides of this famous ether controversy, and the history of the episode is filled with unpleasantness. The dispute might possibly have never originated if the employment of ether in surgery by Dr. Crawford Long of Georgia, four years previous to the epoch-making demonstration at the Massachusetts General Hospital, had been known at the time. Long's prior practical use of this anesthetic in surgical operations has been well authenticated but, unfortunately, the general announcement of his work was not made until many years later so that it played no significant part in the great movement which led to the introduction of painless surgery among the nations of the world.[2]

Emerson took no part in the famous controversy in which the name of his brother-in-law was involved, although he commented upon the dispute in his journal for 1847 in the following philosophic vein:

> Boston divides itself into factions on Dr. Jackson's discovery of ether; and London and Paris contest the priority of having found Neptune in the skies: It is not that Dr. Jackson or Mr. Morton, that Leverrier or Mr. Adams will be in the least enlarged or ameliorated by conceding to them the coveted priority—but there is evidently a feeling of an awful power in this creative saliency, this saliency of thought, this *habit of saliency*, of not pausing but going on, which is a sort of importation and domestication of the Divine Effort in a man. (Jour. VII, 316.)

Dr. Jackson's analytical chemical laboratory, which adjoined his house in Somerset Street, Boston, was opened in 1836 in the same year that the laboratory of his distinguished contemporary, Dr. J. C. Booth, was estab-

[2] For the history of the use of ether as an anesthetic and for details of the famous ether controversy the reader is referred to Edward Waldo Emerson's article, "A History of the Gift of Painless Surgery," in the *Atlantic Monthly*, November, **1896,** page 679, and to Prof. Chauncey D. Leake's article on "The Historical Development of Surgical Anaesthesia" in the *Scientific Monthly* for March, **1925,** page 304. Dr. Jackson's own presentation of the case is contained in his "Manual of Etherization," published at Boston in 1861. Dr. Morton's claims are set forth in an article in *Littell's Living Age* for March 18, **1848.**

lished in Philadelphia. These were the first laboratories in the United States to receive students for practical instruction in chemistry. In Dr. Jackson's laboratory William Channing, John Blake, Joseph Peabody, and many other chemists of eighty years ago received their training. This laboratory was a favorite visiting place of Emerson during his frequent trips to Boston and here he would converse by the hour with his brother-in-law upon the latest discoveries of chemistry. It was here that Emerson enlarged that familiarity with the compounds, utensils, and operations of chemistry which appears on so many pages of his books. When he writes in his "Conduct of Life" that

> Nature is a rag merchant, who works up every shred and ort and end into new creations; like a good chemist whom I found the other day in his laboratory, converting his old shirts into pure white sugar. (Works VI, 262.)

we may be certain that the laboratory where he saw this operation performed was that of his good friend, Dr. Jackson.

Chemists of our day have probably never heard of a proposition that was made in the troubled days before the Civil War to mollify the unruly disposition of Southern slaveholders by chemical sedatives, and they will be interested to read the following entry in Emerson's journal for 1853:

> I read last night a letter from L— T— to L— F— stating that he had learned from a scientific person that sulphate of copper, commonly called blue vitriol, used in small quantities in the manufacture of wheat flour, had important effects in increasing the docility of the people who eat it; and he proposed to introduce such manufacture on a large scale into the Southern States, with a view to reduce the stubbornness of the population, to the end of an easier removal of Slavery. He therefore asks Mr. F— at what price he can supply him with 240 tons of this article, in the autumn, with a prospect of a much larger purchase hereafter. He proceeds to say that great caution must be used in the introduction of this article, and that a number of bakers must be sent with instructions to use it, and that the project should be confidential. Would like also to have Mr. F— take the opinions of Abbott Lawrence, and Senator Everett, and others, who may have information as to the use of this article in Europe.
>
> Mr. F— sent the letter to Dr. Charles T. Jackson, who replied that the use of the article is an outrageous fraud and is forbidden on high penalties in England and France, as it is rank poison. (Jour. VIII, 386–7.)

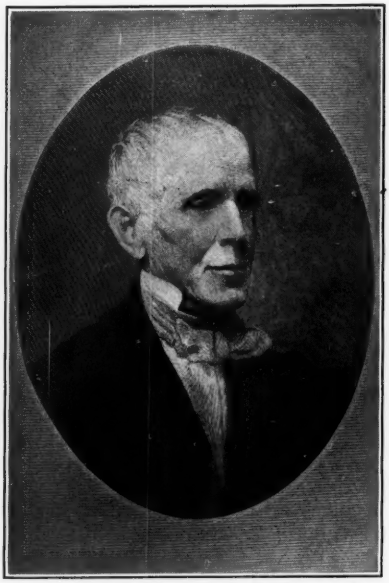
We are led to wonder if this letter was written in earnest or whether it is only another example of the chemical hoax.

We must pass over many other interesting contacts of Emerson with Dr. Jackson in order to say a word about the philosopher's other chemical friends. Foremost among these after Dr. Jackson was Emerson's college classmate, Francis Lowell, and the story of their relations is best told by Emerson himself in this comment in 1874 upon the death of his friend:

> The death of Francis Cabot Lowell is a great loss to me. Now for fifty-seven years since we entered college together, we have been friends, meeting sometimes rarely,

sometimes often; seldom living in the same town, we have always met on the old simple terms. . . . . .

I heard gladly, long since, from Dr. Hobbs, of Waltham, what I had never heard from himself—the story of Lowell's relation to the Chemical Mills in Waltham. His father, Mr. Frank Lowell, Sr., had founded them, and his son inherited in them an important interest. From whatever causes, the property had sadly depreciated. But Mr. Lowell undertook the charge of them himself, studied chemistry with direct reference to the work done in this mill, made himself master of all the processes required; corrected the mistakes; and against all advice stayed therein until its depreciated shares came up to par; then he sold his shares in the property and retired. (Jour. X, 432–3.)[3]



From "Pioneers of Science in America," D. Appleton and Co.

SAMUEL LUTHER DANA (1795–1868), INDUSTRIAL AND AGRICULTURAL CHEMIST

Dr. William F. Channing was another American chemist with whom Emerson was acquainted. He was a son of the celebrated Unitarian minister, William Ellery Channing, and worked as an assistant from 1842 to 1846 in Dr. Jackson's chemical laboratory where he received the ether treatment on various occasions for the accidental inhalation of chlorine. Channing also assisted Jackson in his geological surveys. He was a Fellow of the American Academy of Arts and Sciences and was the inventor of the electric fire alarm.

Another Massachusetts chemist, with whom Emerson came into occasional contact, was Dr. Samuel Luther Dana, author of the famous "Muck Manual" and well known both as an agricultural and industrial chemist. Emerson makes an interesting reference in his Essay upon "Clubs" to the first meeting between Dana and John Dalton.

It happened many years ago that an American chemist carried a letter of introduction to Dr. Dalton of Manchester, England, the author of the theory of atomic proportions, and was coolly enough received by the doctor in the laboratory where he was engaged. Only Dr. Dalton scratched a formula on a scrap of paper and pushed it towards the guest—"Had he seen that?" The visitor scratched on another paper a

[3] This incident is retold by Emerson in his essay upon "Perpetual Forces."

formula describing some results of his own with sulphuric acid and pushed it across the table—"Had he seen that?" The attention of the English chemist was instantly arrested, and they became rapidly acquainted. (Works VII, 238; Jour. VII, 443.)

Among other distinguished American chemists who are mentioned in the pages of Emerson's journals are Prof. Charles Upham Shepard, who was a cousin of the philosopher, and Prof. T. Sterry Hunt, whom he used to see in Boston at the meetings of the Saturday Club.

In 1847 Emerson made his second visit to Europe. Although his time was largely taken up with lecturing in England and Scotland, he found an opportunity to enlarge his friendships among authors, scientists, statesmen, manufacturers, and engineers. Next to his friend Carlyle, no European made a deeper impression upon Emerson than Faraday, whom he always held in highest admiration. In one passage of his journal he writes: "Remember Sir Humphry Davy's best discovery was the discovery of Michael Faraday," and in another place, after quoting from Faraday's lecture upon "Conversation of Force," he remarks:

> Faraday is an excellent writer, and a wise man, and whilst I read him, I think that, if natural philosophy is faithfully written, moral philosophy need not be, for it will find itself expressed in those theses to a perceptive soul. That is, we shall read off the commandments and gospels in chemistry—without need of translation; as we read a Latin or French book to scholars without translation. (Jour. IX, 107.)

A SIMPLE ILLUSTRATION OF THE LAW OF MASS ACTION

S. A. SKINNER, REDLANDS HIGH SCHOOL, REDLANDS, CALIFORNIA

A simple and convenient lecture method for illustrating the application of the law of mass action in suppressing the ionization of a weak acid by its sodium salt is obtained by using acetic acid and sodium acetate with methyl red as an indicator.

Dilute 0.5 cc. of 30% U. S. P. acetic acid with 100 cc. of water. To a few cc. of this solution add a few drops of the methyl red indicator. A characteristic violet-red color due to the hydrogen ion will develop. I am using the LaMotte methyl red, p_H 4.4–6. For convenience I dissolved 0.02 g. of the indicator in 100 cc. ethyl alcohol.

To a few cc. of the acid solution add some crystals of sodium acetate and shake until they dissolve. Test this solution with a few drops of the indicator. The yellow color which develops is indicative of the almost complete suppression of the hydrogen ion due to the increased concentration of the acetate ion.

A CHEMISTRY EXHIBIT

FANNIE L. BELL, RIDGEWOOD HIGH SCHOOL, RIDGEWOOD, NEW JERSEY

Teachers of chemistry in high schools who are looking for outside activities for their classes may be interested in getting up an exhibit similar to one which met with marked success recently in the high school of Ridgewood, New Jersey.

Early in the year I began to talk about the possibilities of having an exhibit which would show the relation of chemistry to everyday life and how chemical processes are involved in the manufacture or refining of many commodities.

I prepared a list suggestive of different possibilities and asked each pupil to select a commodity in which he was interested or for which he thought he might be able to get an exhibit showing its sources, steps in the manufacture, and uses. A letter was put on the blackboard which might be used as a model for writing for these exhibits and a part of a laboratory period was used for writing the letters. Addresses of concerns were obtained from (1) the book by J. O. Frank entitled "Teaching First Year Chemistry," (2) the list published in *The Science Classroom* of January, 1926, to June, 1926, (3) "The Industrial Directory of New Jersey," a revised edition of which has very recently been published, (4) advertisements in current magazines. Each pupil wrote to four or five concerns who manufactured the product he had chosen. It was requested that the reply be sent to the individual pupil in care of the Chemistry Department and, to add prestige, the request was written on Department stationery. Interest was indeed keen when the replies began to come in. There was a marked spirit of courtesy and real interest in almost every reply, even though we did not receive material from every one. The materials were unpacked as they came, examined, and then put away until the time for the final assembling. Each pupil was urged to secure from every available source all the information possible regarding his product.

Prizes were offered for the exhibit showing the most thought on the part of the pupil in arranging it so that it would tell its story most clearly to the visitor.

The first prize was awarded to the pupil who arranged the exhibit on rubber. This showed samples of the crude rubber, various steps in its refining and samples of many common commercial products made from it. The entire exhibit was obtained from a personal friend of one of the pupils and for this reason all of the descriptive material had to be prepared by the pupil, who printed it neatly on cards which were placed in little wooden holders.

The second prize was awarded to the pupil who arranged the exhibit on alloys. This showed actual samples of some of the rare metals which

are used in making some of our most valuable steels and ferro-alloys, such as tungsten, tantalum, and molybdenum. A sample of Duriron was placed in a beaker of dilute sulfuric acid and in another beaker of the same liquid was a piece of ordinary steel and this very clearly showed the non-corrosive property of the Duriron.

Samples of monel metal and of the different grades of the Newark rustless wire screen were shown together with pamphlets describing their commercial uses.

Although thermit cannot be considered an alloy, it was included in this exhibit and there was displayed a sample of thermit, the fuse powder used with it, apparatus needed for its use, and a pipe which had been welded

RUBBER EXHIBIT

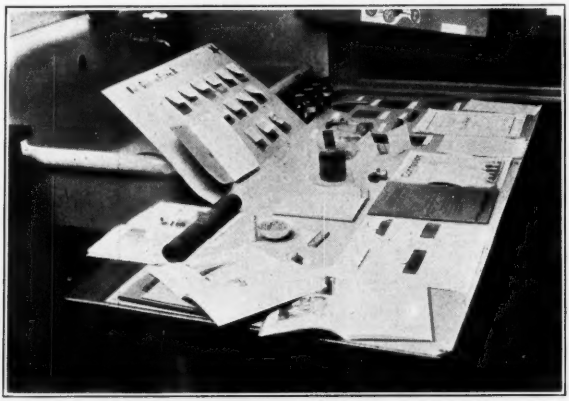
by thermit, together with numerous pamphlets showing its commercial applications.

Honorable mention was given to two exhibits—one dealing with carbon and one with asbestos. The carbon exhibit consisted of (1) a school exhibit sent out by the Acheson Graphite Company, (2) samples of motor brushes which are mixtures of carbon and copper, (3) a sample of adsorbite with a demonstration set up to show how it is used to remove coloring matter from crude sugar, (4) a gas mask with diagrams showing the location of the charcoal and the path of the air through it, (5) posters showing where carbon is found in many common articles such as pencils, lampblack, diamonds, fuels, etc.

The material for the asbestos exhibit was all arranged neatly on four large cardboards. It showed a sample of the rock as it is mined and the fibers of asbestos as they are separated from it, views of the processes

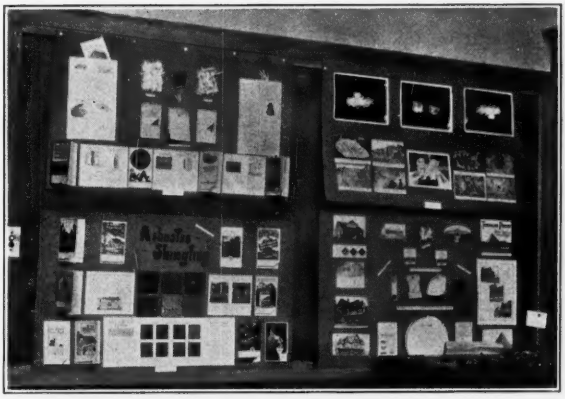
that it goes through in its manufacture and samples of asbestos thread, cloth, filters, and shingles with pictures of each substance in use.

One of the most interesting was a series of exhibits on coal and its products. There was first displayed a large lump of soft coal and some museum specimens showing the leaf and plant structure in coal. Then there were three compound microscopes with sections of coal focused under the high power which clearly showed the cell structure of the wood. These sections of coal are prepared at the Carnegie Institute of Technology and are $^{2}/_{10,000}$ of an inch in thickness. They were loaned to me for the occasion through the courtesy of Mr. Charles R. Fettke. These sections are described in the *Science News Letter* of March 13, 1925, in an article entitled "Coal, Jewel and Fuel," by Dr. David White. Mr. Fettke



ALLOY EXHIBIT

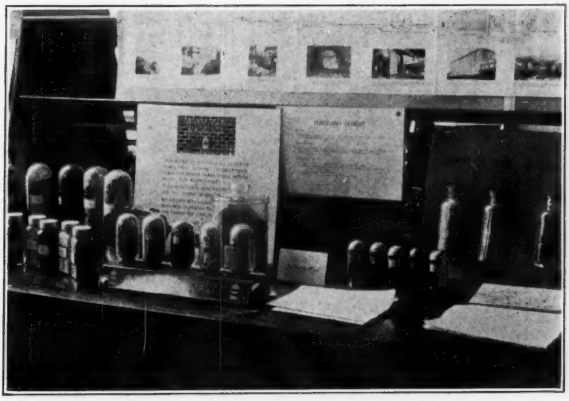
wrote me that he would be glad to extend this same service to other chemistry teachers providing the requests did not become too numerous. Following this we had a much enlarged diagram of a coal gas plant as shown on page 223 in Dull's High School Chemistry. This was enlarged by one of the pupils who also took mechanical drawing and he received credit in that department for the plate. Colored strings led from various parts of the diagram to the product resulting at each point, such as coke, ammonium sulfate, light oil, heavy tar, and finally from the gas tank in the diagram a string led to a Bunsen burner. Samples of these products were furnished by the Seaboard By-Products Coke Company of Jersey City, New Jersey. They also sent us a framed picture of their plant together with descriptive material of what is obtained from a ton of coal. Following this was a large chart published by the Barrett Company showing the many products of coal. There were other charts and "Coal Tar



ASBESTOS EXHIBIT

Trees" from other sources. Then came an exhibit of silk of every color of the rainbow colored by coal-tar dyes and, lastly, copies of the pamphlet, "Molecules and Man."

Manufacturers of cement seemed to be the most generous of all in sending samples which were always neatly put up, showing the original cement rock, limestone, the ground mixture, the clinker and finished product. Two copies of a pamphlet were obtained from The Portland Cement Association so as to be pasted onto a long cardboard and show both sides of the pamphlet. This very clearly illustrated the many steps of the intricate process in the manufacture of cement. Another exhibit that



PORTLAND CEMENT EXHIBIT

PETROLEUM EXHIBIT

told its story clearly was made by the pupil by attaching to a card bottles containing sand, cement, and water, with an arrow leading to a "concrete example." Another poster showed steps in the making of reinforced concrete buildings and huge dams. The Brixment Company also furnished an interesting exhibit of their product used for laying bricks.

The metallurgy of metals proved a fertile field for our exploits. We received very good exhibits showing ores of zinc, materials used in the separation of the metal from its ore, and various grades of the finished

COFFEE AND MILK EXHIBIT

product. To supplement this were several pamphlets and the zinc "tree" showing the uses of zinc.

Similar exhibits were obtained for lead which added quite a touch of color with its various oxides.

The aluminum exhibit showed a sample of crude ore, refined aluminum oxide, pig of the pure metal, samples showing different weights and kinds of finish of aluminum plate. Actual specimens showing the different steps in the evolution of a clothes sprinkler were displayed and a chart showing the making of a tea kettle.

Glass and pottery seemed to be very difficult to obtain, so the pupils who chose these had to resort to the exhibits loaned us by the New Jersey State Museum. However, we did get one exhibit from the Corning Glass works and some good material to show how the glass is made for "daylight" lamps. The State exhibit showed the steps in the blowing of a glass goblet.

While New Jersey leads in making of pottery, strange to say, we obtained nothing from any commercial company in the state. The exhibit of Ballek China from the Museum was very fine. These exhibits were obtained by paying transportation each way.

A set of samples showed the many products obtained from the refining of petroleum together with a large chart which showed the stages of this process.

The exhibit on pencils was very complete. One chart showed the geographic source of every raw material entering into a pencil. Two other charts showed the steps passed through in changing the raw material into the finished product. Two specimens of the mineral graphite as it is found in the mines were also displayed.

A large chart showing steps in the raising, gathering, curing, and blending of coffee was shown together with one of the latest types of percolator. Beside this was a series of charts showing why milk is "the perfect food."

An exhibit which attracted much attention was that of linoleum. This showed a large piece of the cork as taken from the tree, then specimens as it is pulverized, samples of the linseed oil, the oxidized product and the pigments which are mixed with it, and samples of several kinds of the finished product. A poster was made by the pupil in charge showing that there is a design of linoleum suitable for every room in the house. There is an interesting book which accompanies this exhibit that could be used in making other posters to show more clearly the steps in the process of its manufacture. However, two copies of the book should be obtained for this purpose.

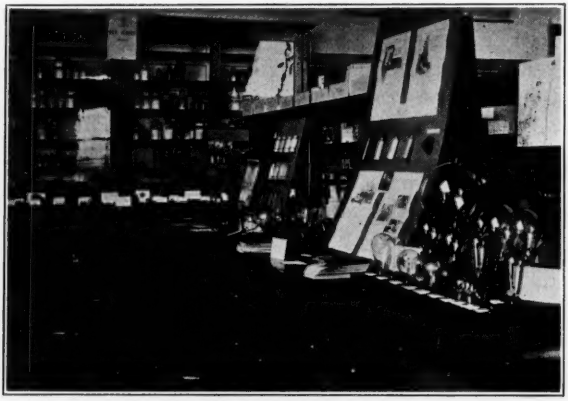
One boy especially interested in electricity volunteered to show all the different kinds of bulbs that he had collected and he made in the manual training department a neat little case for the display of them—all sizes

and all kinds. Another boy made a very fine pen-and-ink diagram showing in detail the construction of an ordinary bulb with the chemical composition of each part.

The Lux Company sent samples of the raw materials, intermediate stages, finished product, and the by-product in the manufacture of Lux. A series of charts led us on a "Trip through Ivorydale." The Bon Ami Company sent us a generous supply of samples of Bon Ami and a piece of feldspar which evidently enters into their product.

The Telephone Company sent us a very interesting series of charts which showed the sources of the twenty-one different things which enter into an ordinary telephone.

The Grinnell Sprinkler Company sent a complete sprinkler head, one



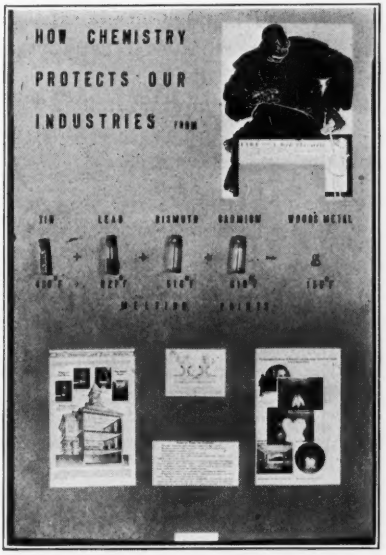
ELECTRIC LIGHT BULB EXHIBIT

cut in cross section, and one unassembled, together with their book, "Prevention of Fire Tragedies." A poster which told its story clearly was made to accompany this exhibit.

"How Chemistry Protects Our Industries from" was printed on a cardboard followed by the big red demon cut from a Hartford Fire Insurance advertisement. Below this, bottles containing tin, lead, bismuth, and cadmium were attached and then, following the arrow, a piece of Wood's metal. Below each was given its melting point in Fahrenheit degrees (for the sake of the general public) and the contrast between the melting point of each and that of the alloy was striking. Below this was a diagram taken from page 25 in Gray, Sandifur, and Hanna's "Fundamentals of Chemistry," showing exactly what happens when the Wood's metal melts. Below this were diagrams

showing how the sprinkler system is installed and how fire can be extinguished "without human aid."

It was my impression, as I watched the people pass through and heard their remarks, that the majority of people whom we consider the intelligent class of a community were very much surprised at the important part chemistry is playing in our everyday lives and many were amazed at some of the facts brought out by these exhibits which we as chemistry teachers consider as very matter-of-fact information. Yet the general public does not realize the tremendous importance of chemistry and here, I believe, is a wonderful means of "selling" it to them.



AUTOMATIC SPRINKLER POSTER

This is also a means of collecting valuable material for future use in the classroom and the exhibits should be preserved as a sort of chemistry museum in each school. But, of course, the two great objects of such an exhibit are: first, to create an interest in the subject in the present class; and second, to stimulate an interest in the student body so that those of the coming classes will want to take the course because they see that it has a really vital interest for them.

It was also my impression that it would be more effective to have "The Chemistry Show" limited to perhaps six or not more than ten exhibits in a single year and then make it an annual affair. In this way a group of pupils could work on one exhibit and then work it out more in detail so that each step is so plainly shown that "he who runs may read." A spirit of competition to make each year's exhibit better than the one of the preceding year would naturally develop. Also if the number of exhibits were limited the work for the teacher in charge would be much less, but the net result would be greater in a period of a few years.

I can see many ways in which this could be worked out along different lines that would provide both valuable teaching material and also material of interest to the general public. For example, an exhibit showing the great amount of iron that is lost each year through rust and the many

different ways in which we attempt to prevent this loss could be shown through posters and actual specimens.

While we did not get any results I would think that some water softening company would be glad to do a bit of advertising in this way, or one might make a crude water softening plant from laboratory apparatus.

Then there is always the possibility that one or more pupils in a class may be intimately connected with some manufacturing plant of the community and in that way a very complete exhibit can be obtained. No doubt other states have industrial directories similar to the one mentioned for New Jersey and this would furnish sources for material. In my exhibit I marked with a red star each New Jersey industry. There are many opportunities to get advertising material and pamphlets for distribution along the lines of cereal, baking powder, and prepared foods if one were working out an exhibit with a class in household chemistry.

The list that follows gives the addresses of the firms from whom I actually received material.

Alloys

Fansteel Products Company, North Chicago, Illinois.
The Electro-Alloys Company, Taylor Street and Abbey Road, Elyria, Ohio.
The Duriron Company, Box 1090, Dayton, Ohio.
Newark Wire Cloth Company, Newark, New Jersey.
Standard Alloys Company, Vanadium Building, Pittsburgh, Pennsylvania.
The Titanium Alloy Manufacturing Company, Niagara Falls, New York.
The American Stainless Steel Company, Commonwealth Building, Pittsburgh, Pennsylvania.
The International Nickel Company, 67 Wall Street, New York City.
Whitehead Metal Products Company, 261 Canal Street, New York City.

Aluminum

Aluminum Goods Manufacturing Company, Manitorvoc, Wisconsin.
The Aluminum Cooking Utensil Company, New Kensington, Pennsylvania.

Asbestos

Johns-Manville Company, 292 Madison Avenue, New York City.
Asbestos Shingle, Slate and Sheathing Company, Ambler, Pennsylvania.

Batteries

The Burgess Battery Company, Madison, Wisconsin.
The Electric Storage Battery Company, Philadelphia, Pennsylvania.
National Carbon Company, Inc., Long Island City, New York.

Carbon

The Acheson Graphite Company, Niagara Falls, New York.
Stackpole Carbon Company, Saint Mary's, Pennsylvania.
Speer Carbon Company, Saint Mary's, Pennsylvania.
The Barneby-Cheney Engineering Company, P. O. Box 66, Columbus, Ohio.

Carborundum

The Carborundum Company, Niagara Falls, New York.

Cement

Alpha Portland Cement Company, Easton, Pennsylvania.
Universal Portland Cement Company, Pittsburgh Plant, Universal, Pennsylvania.
Atlas Portland Cement Company, 25 Broadway, New York City.
The Best Brothers, Keene's Cement Company, Medicine Lodge, Kansas.
The Portland Cement Association, 111 West Washington Street, Chicago, Illinois.
Louisville Cement Company, Louisville, Kentucky.

Coffee

Cheek-Neal Coffee Company, 2nd Avenue and 40th Street, Brooklyn, New York.

Coal (slides)

Charles R. Fettke, Carnegie Institute of Technology, Schenley Park, Pittsburgh, Pennsylvania.

Cocoa

Walter Baker and Company, Ltd., Dorchester, Massachusetts.
Royal Cocoa Company, 1600 Haddon Avenue, Camden, New Jersey.
Chocolate Sales Corporation, 19 Chocolate Avenue, Hershey, Pennsylvania.

Duco

E. I. du Pont de Nemours and Company, Parlin, New Jersey.

Fire Extinguishers

Pyrene Manufacturing Company, P. O. Box 621, Newark, New Jersey.
General Fire Extinguisher Company, Providence, Rhode Island.

Glass

Celestialite Division, Gleason-Tiebout Glass Company, 200 Fifth Avenue, New York City.
The Corning Glass Works, Corning, New York.

Ink

The Carter's Ink Company, New York City.

Lead

Carter White Lead Company, 12042 South Peoria Street, Chicago, Illinois.
Eagle-Picher Lead Company, 208 South LaSalle Street, Chicago, Illinois.

Linoleum

Armstrong Cork Company, Linoleum Division, Lancaster, Pennsylvania.
The George W. Blabon Company, Nicetown Station, Philadelphia, Pennsylvania.

Lime and Limestone

National Lime Association, Washington, D. C.
American Lime and Stone Company, Bellefonte, Pennsylvania.

Pencils

Eberhard Faber, 37 Greenpoint Avenue, Brooklyn, New York.
Joseph Dixon Crucible Company, Jersey City, New Jersey.
American Lead Pencil Company, 220 Fifth Avenue, New York City.

Pens

The Esterbrook Steel Pen Manufacturing Company, Camden, New Jersey.
L. E. Waterman Company, 191 Broadway, New York City.
Spencerian Pen Company, New York City.

Petroleum

Standard Oil Company of New Jersey, 26 Broadway, Room 777, New York City.
The Texas Company.
The Quaker State Oil Refining Company, Oil City, Pennsylvania.

Pottery

Coors Porcelain Company, Golden, Colorado.

Rubber

The Goodyear Tire and Rubber Company, 1144 East Market Street, Akron, Ohio, have an exhibit similar to mine which they will send for five dollars.
The Hood Rubber Company, Boston, Massachusetts.

Soap

Lever Brothers Company, Cambridge, Massachusetts.
Kirkman and Son, Brooklyn, New York.
The Proctor and Gamble Company, Cincinnati, sent the "Trip through Ivorydale," but charge five dollars for their sample exhibit.
The Bon Ami Company, Inc., 17 Battery Place, New York City.

Telephone

The Westric Company, 195 Broadway, New York City.

Thermit

Metal and Thermit Corporation, 120 Broadway, New York City.

Tar (coal-tar products)

The Barret Company, 17 Battery Place, New York City.
The Seaboard By-Product Coke Company, Jersey City, New Jersey.
E. I. du Pont de Nemours and Company, Wilmington, Delaware (dyes).

Zinc

The New Jersey Zinc Company, Franklin Furnace, New Jersey.
American Zinc Sales Company, Equitable Building, New York City.

Lead Adulterant in Snuff Poisons Three. The social vogue of snuff dipping went out with hoop skirts and powdered hair but enough is still used to make it profitable to insert in a very cheap quality an adulterant that has proved to be distinctly poisonous.

Dr. Joseph Uttal of the Mount Sinai Hospital has reported to the American Medical Association three cases of lead poisoning directly traceable to snuff containing lead chromate that proved upon investigation to have been put in for coloring matter. The snuff in question was the cheapest on the market and put out by one manufacturer who claimed ignorance of the poisonous properties of lead compounds. The problem is being investigated by the commissioner of health.—*Science Service*

CHEMISTRY IN THE DEVELOPMENT OF THE GAS INDUSTRY

Minor C. K. Jones, Chief Chemist, Consolidated Gas, Electric Light & Power Company, Baltimore, Maryland

As in the day when were spoken the immortal words, "where a man's treasure is, there will his heart be also," through the centuries man has carried on his endless search for riches and eternal health and life. It was this search which inspired the alchemist to carry on his labors in spite of the fact that the reward for his research was often only persecution and poverty. It was through the work of one of the last of these forerunners of the modern chemist that the very name of gas, and the gas industry, came into being.

Jan Baptista van Helmont (1577–1644), Flemish physician and chemist, after having practised medicine, gave himself up to chemical research, believing in the Philosopher's Stone and the transmutation of the baser metals into gold. About 1609, in the course of these experiments, he discovered and reported that heated coal "did belch forth a wild spirit or breath. This spirit, up to the present time unknown, not susceptible of being confined to vessels, nor capable of being produced as a visible body, I call by the name of gas." The word gas may have been suggested to van Helmont from the German and Dutch words, "*geist*" for "ghost," or "*gast*" meaning yeast; or perhaps from the Greek word *χάος* meaning an unformed mass. Thus, although gas undoubtedly had been known since the days of the Delphian Oracle, it remained for a chemist to name it and lay the foundations for further research.

Men with an inclination for the sciences continued to experiment. In the *Philosophical Transactions* for 1667 Thomas Shirley gave the earliest account of an illuminating gas which he had noticed issuing from a spring near Wigan, in England, although he did not recognize its origin. In 1691 Robert Boyle observed the production of an illuminating gas from the carbonization of coal and other forms of vegetable matter, and in 1726 Dr. Stephen Hales published "Vegetable Staticks," which made reference to the carbonization of coal.

Another earlier experimenter was Dr. John Clayton, Rector of Crofton, in Yorkshire, England. About 1665, after having investigated the inflammable gases at Wigan, he secured coal from there and, by heating it in a closed vessel, found that a "spirit which issued out caught fire at the flame of a candle." Dr. Clayton collected the gas in bladders, and exhibited its properties to his friends by lighting the gas as it would escape through holes pricked in the skin with a pin. His experiments were described in the *Philosophical Transactions* of 1739.

Several other men demonstrated the production of gas from coal, but no practical application was made of the discoveries until William Mur-

dock, in the year 1792, lighted his own house at Redruth, in Cornwall, with coal gas made in an iron retort and carried through 70 feet of tinned and copper tubes. Murdock was employed by James Watt, developer of the steam engine, and in 1798 transferred his activities to the Soho Foundry of Boulton, Watts & Company. A large-scale apparatus was installed here and the principal shops lighted with gas. Murdock continued to experiment in gas production and the success of his undertaking is a tribute to his genius. For a paper presented before the Royal Society of Arts in 1808, describing an installation at Manchester, he was awarded the Rumford Gold Medal. Already the discoveries of the chemists were beginning to yield returns.

Among the other investigators, Lavoisier in 1781 invented a gas holder. In 1784, Jean Pierre Minckelers, of the University of Louvain, demonstrated to his class the production of gas from coal. The experiments of Philippe Lebon in France, which were similar to those of Murdock, attracted the attention of Frederick Albert Winsor, a German, and led to the establishment of the first gas company in the world in London in 1812. Samuel Clegg, who had been an assistant to Murdock, became Chief Engineer of the new company. The commercial production of gas was now established, just about two hundred years after van Helmont, working in his laboratory in Brussels, had given "gas" to the world.

William Henry, well-known chemist of Manchester, suggested the use of lime as a purifier, the gas at first having been burned in the crude state, with all carbon bisulfide, hydrogen sulfide, ammonia, and other impurities in the gas. Here the chemist was able to remove the cause of the violent headaches which resulted from Winsor's public exhibitions. With crude methods in use, the gas plants continued to cause dissatisfaction by the smell resulting from their operations. In 1817, Reuben Philips, of Exeter, introduced the dry lime purifier. Lanning brought out the use of iron oxide and shavings.

The introduction of fireclay retorts, by John Grafton, in 1820, revolutionized the gas industry. Numerous advantages resulted, such as the possibility of a larger charge of coal and higher temperatures. Due to the chemical process resulting from the higher temperatures, a larger yield of gas was secured, its composition was changed as a result of the cracking of the paraffins to form benzol hydrocarbons, and a better quality of coke was produced.

On June 17, 1816, the first gas company in the United States was founded at Baltimore by the passage of an ordinance permitting Rembrandt Peale and others to manufacture and distribute gas. The company, The Gas Light Company of Baltimore, was incorporated February 5, 1817, and first lighted a street on February 17, 1817.

After it was firmly established, the gas industry came more and more to depend upon the services of the chemist. Indeed, the chemist has made the efficient and economical operation of the gas plant possible. Purchased materials for gas plant operations, such as coal, gas oil, lubricating oil, water, acid, and alkalies, are all carefully analyzed, both as a basis of payment and accurately to control their use. The various manufacturing processes are carried on properly only with the aid of the laboratory. The quality of the by-products is determined and maintained by frequent chemical tests.

Chemical research has pointed out many changes in operating practice which reduce the cost and improve the efficiency of the manufacture and distribution of gas. The industry has received the benefit of contributions from both its research chemists, and from its operating chemists and chemical engineers.[1] A few contemporary investigators may well be mentioned.

The work of W. A. Dunkley on the use of iron oxide for hydrogen sulfide removal has been important.[2] A study of iron sulfide with reference to gas purification has been made by L. Gedel.[3] Recent liquid purification processes include the Feld Process, the Seaboard Process,[4] and the Sulfur Recovery Process.

The formation of carbon disulfide in gas manufacture has been investigated by W. J. Huff at the Johns Hopkins University.[5]

The removal of hydrocyanic acid from gas to prevent its corrosive effect in the distribution system and its detrimental effect on oxide purification, has been another of the chemical problems of the industry.[6]

The compounds of carbon monoxide with iron, iron carbonyls, have been studied by A. C. Fieldner and G. W. Jones.[7]

The corrosive action of oxygen and moisture in gas has received considerable study. The formation of and removal of naphthalene in gas is under chemical control. The research of R. L. Brown[8] under a coöperative arrangement between the American Gas Association and the United States Bureau of Mines has furnished a solution of the problem of the formation of gummy or resinous deposits in pipes and meters.

One of the large fields of scientific investigation in the gas industry

[1] C. A. Lunn, *Proc. Am. Gas Assoc.*, **1924,** 1045.
[2] W. A. Dunkley, *Univ. of Ill. Eng. Exp. Sta. Bull.*, **119** (1921).
[3] L. Gedel, *Am. Gas Assoc. Monthly*, **4,** 565 (Sept., 1922).
[4] F. W. Sperr, Jr., *Proc. Am. Gas Assoc.*, **1923,** 1200.
[5] W. J. Huff, *Ind. Eng. Chem.*, **18,** 357 (April, 1926).
[6] A. R. Powell, *Am. Gas Assoc. Monthly*, **4,** 621 (Oct., 1922).
[7] A. C. Fieldner and G. W. Jones, *Ibid.*, **6,** 439 (July, 1924).
[8] R. L. Brown, *Proc. Am. Gas Assoc.*, **1924,** 1353.

has been the study of the constitution and physical and chemical properties of coal and coke. In his Chandler Medal Lecture, S. W. Parr[9] mentions that there are over five hundred separate articles dealing with the chemical constitution of coal. Recently published work in the study of coal and coke includes the names of A. C. Fieldner, H. C. Porter, C. J. Ramsburg, H. J. Rose, O. O. Malleis, W. A. Selvig, R. T. Haslam, W. J. Huff, F. Fisher, R. V. Wheeler, A. R. Powell, J. J. Morgan, and others.

A recent article by W. H. Fulweiler[10] on water gas manufacture describes, with numerous references, its historical development and recent progress, describing reactions during the blow and run, use of bituminous coal, the blow-run, back run and Chrisman cycle processes, and the thermal efficiency of the water gas process.

Among those contributing to the study of tar, light oils, and gas oils in recent years may be mentioned J. M. Weiss,[11] W. J. Huff,[12] S. R. Church,[13] C. R. Downs,[14] A. L. Dean,[15] L. J. Willien,[16] R. S. McBride,[17] T. A. Mighill,[18] and E. F. Pohlmann.[19]

New processes of interest to the gas industry include the methanol synthesis,[20] the synthesis of higher alcohols (Synthol),[21] synthesis of gasoline at ordinary pressure from water gas,[22] the catalytical enrichment of blue gas,[23] and the Bergius process for conversion of coal into oil.[24]

The field of analytical methods and tests for the gas industry has received a large amount of attention. The Gas Chemist's Handbook,[25] now in its second revision and third publication, has become a recognized standard and is a tribute to the coöperative efforts of the chemists of the

[9] *Ind. Eng. Chem.*, **18,** 640–8 (1926).

[10] W. H. Fulweiler, Am. Gas Assoc., 1926 Chemical Committee Report, Chap. 4.

[11] J. M. Weiss and C. R. Downs, *Ind. Eng. Chem.*, **15,** 1022 (1923).

[12] W. J. Huff, *Ibid.*, **10,** 1016 (1918).

[13] S. R. Church, *Proc. Am. Wood Pres. Assoc.*, **1918,** 160.

[14] C. R. Downs and J. M. Weiss, *Ind. Eng. Chem.*, **15,** 1022 (1923).

[15] A. L. Dean, *J. Ind. Eng. Chem.*, **6,** 366 (1914).

[16] L. J. Willien, *Gas Age-Record*, **55,** 603, 663, 668, 670 (1925).

[17] R. S. McBride, *Ind. Eng. Chem.*, **10,** 111 (1918).

[18] T. A. Mighill at Am. Gas Assoc. Production Conference, June, 1927.

[19] E. F. Pohlmann, Am. Gas Assoc., 1926, Chemical Committee Report, p. 101.

[20] Badische Anilin and Soda-Fabrik P. R. P., **293,** 787 (March, 8, 1913); U. S. P., 1,201,850, Oct. 19, 1926.

[21] F. Fischer, *Ind. Eng. Chem.*, **17,** 574 (1925).

[22] *Brennstoff-Chemie*, **7,** 97 (1926); and "Fuels in Science and Practice," **5,** 6 (1926), 263.

[23] R. T. Haslam and H. O. Forrest, *Gas Age-Record*, **52,** 615 (Nov. 17, 1923).

[24] *Engineering*, **120,** 675 (1925).

[25] O. A. Morhous, C. C. Tutwiler, and E. C. Uhlig, *Gas Age-Record*, **49,** 437 (1922).

gas industry. An article by A. F. Kunberger[26] covers recent developments in analytical methods in great detail.

Scientific research has contributed to the proper utilization of gas in domestic and industrial appliances.[27] The organization and operation of the American Gas Association Testing Laboratory[28] is the result of an appreciation by the industry of its value in this field.

There are many other well-known names among chemical contemporaries in the gas industry to whom the industry is indebted.

The name of Alexander C. Humphreys should be mentioned in any discussion of the development of the gas industry. He has contributed largely to the scientific progress of the gas industry as an engineer, business administrator, and educator.

The absolute dependence of the gas industry on chemistry for its development is the outstanding fact of a study of the by-products of the gas plant. A picture of the practices of other days, which the modern gas plant executive would regard with dismay, is to be found in the following quotation from "Reminiscences" of a retired gas plant superintendent:

"The unpurified gas from the retort house passed over to the washers and condensers, which removed the tar and ammonia from the gas. The tar was run into a well and pumped up to the top of the stack of benches of retorts into rectangular cast iron boxes—one box for each bench of retorts—and was led from these boxes through pipes to the furnaces and allowed to drip on the hot coke and there consumed. There was no market for tar at that time. When the Gas Company first began the manufacture of gas the tar was allowed to run into Jones' Falls and soon became a public nuisance. It was then hauled in barrels and dumped on the marshes somewhere near Fell's Point and set on fire and burned. This method of disposing of the tar also became objectionable, and it was taken on vessels several miles down the bay and dumped overboard. In after years it became a valuable by-product of the gas industry."

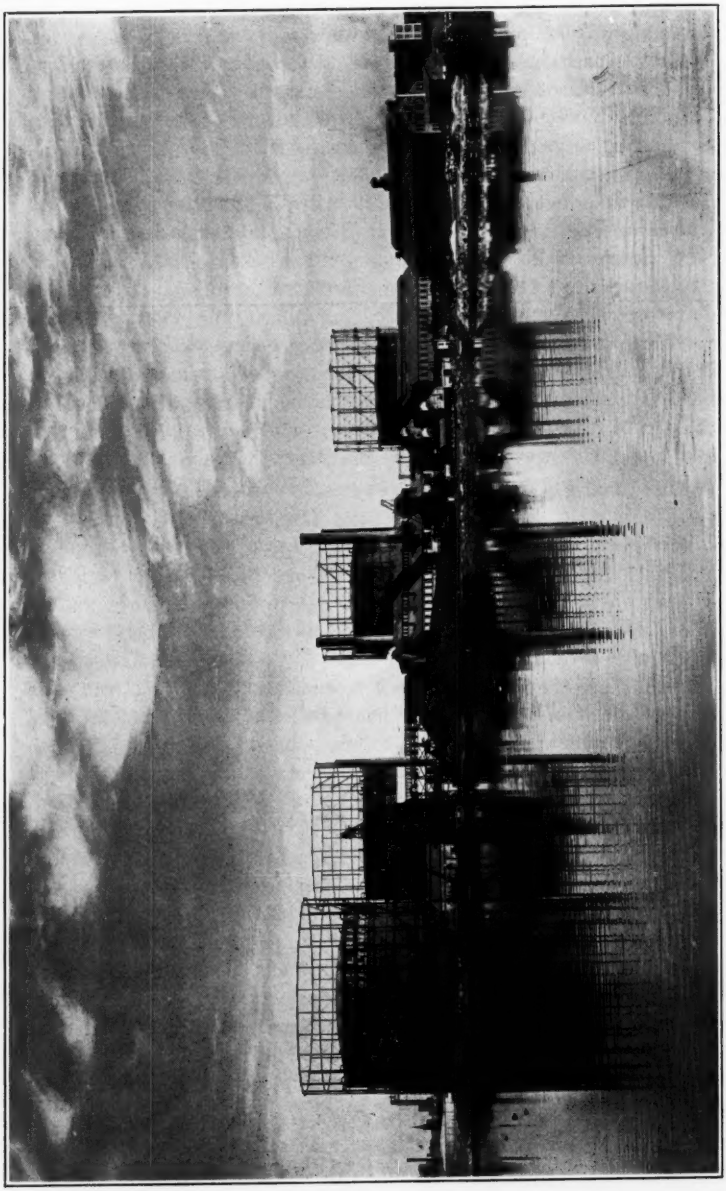
Chemistry has changed these conditions and the objectionable by-products that were so hard to dispose of are now valuable articles of commerce. Chemistry has made possible the sale of ammonia products such as concentrated ammonia liquor and ammonium sulfate. It has made possible the development of light oil products such as benzol, toluol, xylol, and solvent naphtha. The chemist has found gas tar to yield, in addition to quantities of these "light oils," such valuable products as naphthalene, carbolic acid, cresols, anthracene, and pitch.

These by-products have so grown in importance that coke production

[26] A. F. Kunberger, Am. Gas Assoc., 1926, Chemical Committee Report, p. 168.

[27] W. M. Berry, I. V. Brumbaugh, *et al.*, Bur. Standards, *Tech. Papers*, **221** (1922).

[28] *Am. Gas Assoc. Monthly*, **9**, 259 (May, 1927), and R. M. Conner, *Am. Gas Assoc. Monthly*, **9**, 269 (May, 1927).



A MODERN GAS PLANT *Consolidated Gas, Electric Light & Power Co. of Baltimore*

Spring Gardens Station

had to be revised until the modern coke-oven plant is essentially a by-product recovery plant. They supply the world with the base for a thousand products, such as dyes in a variety and quality surpassing nature itself; substances for use in medicine, surgery, and sanitation; substances which add to the comfort and length of our life; and some of the most powerful explosives known to man.

A study of the relation of chemistry to the development of the coal-tar colors is almost a study of the development of chemistry itself. Quoting from an article by Dr. A. R. Risteen, the following are a few of the more notable events in the history of the development of the coal-tar industry, as given by Benedikt:

"Naphthalene was first discovered in tar in 1820 by Garden; anthracene in 1832 by Dumas; and phenol in 1834 by Mitscherlich. Faraday discovered benzene in 1825, but its presence in coal-tar was not recognized until 1845, by A. W. Hofmann. In 1846 Unverdorben discovered aniline among the products obtained in the dry distillation of indigo, and in 1834 Runge proved its existence in coal-tar, and observed that it gives brilliant colors when brought into contact with chloride of lime. In 1834 Mitscherlich discovered nitrobenzene, and in 1842 Zinin showed that aniline can be manufactured by the reduction of nitrobenzene. The last-mentioned discovery was of exceeding importance, for although aniline occurs in coal-tar it is in such small quantities that it could not be profitably extracted on a commercial scale. In 1854 Bechamp greatly improved the process of manufacturing aniline from nitrobenzene, and in 1856 Perkins prepared mauve (the first aniline dye) on a large scale. In 1858 A. W. Hofmann published a paper in which he showed that magenta (aniline red) can be prepared by the action of carbon tetrachloride upon aniline, and in 1859 Verguin first manufactured magenta in quantity. During the next few years various other colors were discovered and placed on the market. Aniline black was discovered by Lightfoot in 1863. Pelletier and Walter discovered toluene in 1837, and in 1848 Mansfield showed that this substance occurs in coal tar. The coal-tar industry was greatly stimulated when Graebe and Liebermann effected the synthesis of alizarin in 1868, thereby opening up a new and important field of chemical activity. Previous to this date alizarin was obtained from madder-root, but it is now almost exclusively manufactured from anthracene. Baeyer produced the first eosin dye in 1874. The synthesis of indigo was the result of a long series of investigations, the final step of which was taken by Baeyer in 1878, and in 1880 a German company placed a substance known as nitrophenyl-propiolic acid on the market, for depositing artificial indigo upon fibres by Baeyer's method."

Tar has given us, through chemistry, such substances as saccharine, discovered at Johns Hopkins University under the guidance of Dr. Ira

Remsen. We have explosives such as trinitrotoluene, picric acid, and nitronaphthalene. We have perfumes, solvents, motor fuel, and fuel oil.

The ammonium products give us fertilizers, explosives, and a refrigerating medium. Chemistry, after discovering the manufacture of gas itself, has discovered new industries in the development of its by-products.

The development of gas lighting to its present efficient state resulted from chemical researches in pure science. As the light from a flame is the result of the heating of solid particles to incandescence, gas light may be secured by supplying the incandescent material from the decomposition of the gas in the process of combustion, or by the decomposition of the gas in a Bunsen burner, with non-luminous flame, with the permanent incandescing material supplied by the apparatus itself.

The second method of producing the gas light, that of supplying a permanent incandescing material as a part of the gas burner, was made possible by the invention of the Bunsen flame, designed by Professor Bunsen, professor of chemistry in Heidelberg. This burner gives a non-luminous flame with complete combustion and utilizes the maximum heating value of the gas.

Dr. Carl Auer von Welsbach, of Vienna, was the first one who made a commercial success of the incandescent light. He worked with Bunsen in Heidelberg in the interest of chemistry alone, namely, the study of the rare earths, centering his attention on the oxide of erbium. In connection with its spectroscopic study, he saturated a cotton fabric with a solution of erbium and, by burning off the cotton, obtained the ash in the flame, producing an intense green light. The idea then occurred to Welsbach to utilize this property for the production of an incandescent light. He continued his experiments with the stable oxides of the rare earths, especially those giving white light, with the resulting success of the incandescent mantle.

It is interesting to note that the chemical element, illinium, the first element to be discovered on American soil, was isolated by University of Illinois chemists from four hundred pounds of gas light mantle material donated by a gas light manufacturer.[29]

The Bunsen flame, a discovery of research in pure chemistry, has made possible the success of gas as a source of heat in industrial and commercial fields, as well as for domestic uses. Indeed, most of the vast quantity of gas used today gives up its heat by means of this principle.

The following table shows clearly the continued increase in the amount of gas made in the United States in recent years.

[29] *Am. Gas Assoc. Monthly*, **9**, 175 (1927).

PRODUCTION OF MANUFACTURED GAS IN UNITED STATES[30]

(*In Thousands of Cubic Feet*)

1902	92,714,667
1905	112,444,237
1910	149,430,549
1915	204,309,522
1920	319,888,000
1921	326,950,900
1922	350,000,000
1923	384,722,000
1924	405,200,000
1925	421,814,000
1926	459,326,000
1927	475,000,000

"The gas industry faces 1928 with an overwhelming array of economic factors in its favor. Preliminary estimates of sales of manufactured gas for 1927 reveal a large increase over the record-breaking total registered

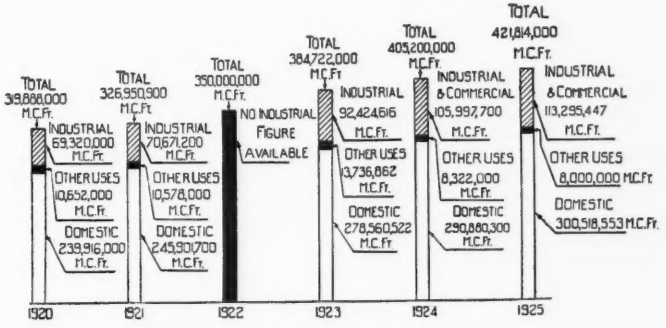


FIG. 1
ANNUAL SALES 1920-1925
CLASSIFIED ACCORDING TO USES

in 1926. The latest figures for sales of manufactured and natural gas total 1,714,000,000,000 cubic feet.

"The manufactured gas industry has not reported a decrease in annual sales in the last 21 years. Sales have increased 352 per cent in 25 years, while the population of the country has increased only 50 per cent.

"Manufactured gas companies now serve 11,400,000 customers, representing an increase of 350,000 over 1926. The miles of main total 91,000, and the invested capital is placed at $2,700,000,000. Gross operating

[30] 1902—*Am. Gas Assoc. Monthly*, **10**, 4 (1928).
1905–1915—*Balto. Gas & Elec. News*, **16**, 128 (1927).
1920–1925—Am. Gas Assoc. *Statistical Bulletin*, **3** (Jan., 1926).
1926–1927—Am. Gas Assoc. Preliminary Estimates.

revenue for 1927 is estimated at $520,000,000, or an increase of $20,000,000 over 1926."[31]

Figure 1 gives a graphic representation of gas sales classified according to uses.[32] The large amount of gas used in industrial and commercial fields is clearly indicated. The rapid growth of the industry may be seen from the fact that the amount of gas sold for industrial and commercial uses alone, in 1925, is greater than the entire sales for all purposes in 1905.

Considerable interest is often manifest regarding the quantity of gas made by the various important processes, especially in connection with the relative value of proposed chemical research in the different fields. The tabulation below, compiled from American Gas Association statistics, shows the proportion of gas made by each process.

PERCENTAGES OF GAS MADE BY VARIOUS PROCESSES

	1920 %	1921 %	1922 %	1923 %	1924 %	1925 %
Carbureted water gas	60	62	63	61	61	58
Coal gas	19	19	15	16	16	16
Oil gas	7	8	7	6	7	7
Coke oven gas distributed for public use	14*	11	15	17	16	19
	100	100	100	100	100	100

* Includes all other processes.

Sir Arthur Duckham, K.C.B., first president of the Institution of Chemical Engineers (London), is reported to have said, when sought as the first president of the Institution, that he knew of no chemical engineers save gas engineers.[33] This statement aptly expresses the fact that while the discovery and development of the gas industry has been intimately connected with chemistry, the industry has at the same time contributed its art, developing gas engineering as a science that is not merely a branch of chemistry or chemical engineering. Fitting recognition of the full transition of the chemist first recognizing gas to the gas engineer of today, is to be found, more than in the recent expansion of the gas industry, in the fact that in 1923, over three hundred years after van Helmont's discovery, and one hundred years after America's first gas company was established, in the same city, Johns Hopkins University was chosen as the first University in this country in which to establish a Department of Gas Engineering. This act recognizes the great contribution of chemistry to the gas industry—gas engineering—wherein are welded chemistry and engineering, and which will prove that smokeless cities are possible and that "if it is done with heat, you can do it better with gas."

[31] *Am. Gas Assoc. Monthly*, **10**, 4 (1928).

[32] Am. Gas Assoc. *Statistical Bulletin*, **3** (Jan., 1926).

[33] W. J. Huff, "Education in Chemical Engineering and in Gas Engineering," address

THE TEACHING OF CHEMISTRY IN A DEMOCRACY*

V. R. KOKATNUR, 26 VAN CORTLAND PLACE, ARLINGTON, NEW JERSEY

It would appear somewhat ridiculous to speak of different types of education according to different geographical and political associations. But the fact is that education in a democracy is of necessity quite different from that of other countries.

Primarily all education is based on caste or class system, that is, on the purposive selection of the student body. Such selection is not feasible in a democracy where education is looked upon as the birthright of every man. It is necessary, therefore, that education in a democracy be based on a method other than selection.

The aim of education, admittedly, is not only the accumulation of facts and experiences, but of a knowledge of how to apply them as well to the specific problem at hand. The well-educated man is not one who remembers or stores up many facts and experiences, but one who knows how to apply his experiences to his own problems. In other words, one with the best common sense is the best educated.

So, to be chemically educated is to have a goodly amount of chemical sense. Thus, the problem of chemical education in a democracy reduces itself to instilling this chemical sense in the student body.

The underlying explanation of the possession of such common sense or chemical sense is to be found in the ability to see the factor common between accumulated experiences and arising situations. If a student is repeatedly shown the common factors between a known and a new experience, he begins instinctively to see such commonness in problems confronting him later in life. Given similar experience and similar facts, the mind reacts in a definite way. The apparent difference in reaction is due merely to inability to sense the analogy between the old and the new.

Since selection of the student body in a democracy is undesirable and yet some levelling of the student experiences is essential, a knowledge of how to classify student types is necessary. Unless a teacher knows the earmarks of these types, it will be difficult for him to arrive at the common denominator of his student body from which as a basis he can point out the familiar aspects in the new problems he presents.

Students can be divided into: (*a*) general memory type, (*b*) auditory memory type, (*c*) visual memory type, (*d*) reasoning type.

Teaching in a democracy should contain elements to satisfy all the types of students. It should be pliable enough to change according to the reactions shown by the students. The failure to reach all types

* Paper presented before the Division of Chemical Education of the A. C. S. at Philadelphia, Pa., September 7, 1926.

results not only in general lack of interest, but often in revulsion against the whole system of scientific education.

This is well expressed by President Glenn Frank, of the University of Wisconsin, in his observation regarding the effect of cold non-humanized technical scholarship on our common life. In his essay on "The Evangelism of Science," published some time ago in the *New York Evening World*, he rightly blames when he says, "The scientists and scholars must share the blame for all this (prevalence of obsolete opinions, dead dogmas, silly superstitions). Unfortunately many of these ideas (scientific ideas) are today buried under the jargon of technical scholarship and effectively insulated from contact with our common life. If we are to save the results of scientific research from slander . . . then these contributions must be translated into the common tongue . . . And these results of scientific research will never be used in any broadly effective way until the man in the street has at least bowing acquaintance with them. We must somehow find ways and means for thrusting the results of scientific research into the stream of common thought and for making them the basis of our public policies and social procedures . . ."

The following are examples of the analogy method of teaching.

Organic chemistry is usually distinguished from inorganic chemistry. This creates a lack of sequence and thus bewilders the student. If continuity were shown, it would be distinctly helpful to him. This can be done by showing that organic chemistry is a specialized branch consisting of a few elements such as C, H, N, O, and P.

(*a*) The chain idea is common to elements like O as in ozone, S as in polysulfides, and even in allotropic forms of elements.

(*b*) Structural and stereoisomerism is common to many inorganic compounds.

(*c*) Hydrocarbons may be looked upon as elements from which types like oxides, sulfides, sulfoxides, chlorides, nitrates, amines, etc., can be formed.

Chemistry can be humanized by pointing out the resemblance between a saturated compound and a rich man; both pay a good price for everything they receive. This gives rise to what is called "the law of substitution." The unsaturated compounds might similarly be compared to beggars; they both accept gifts, but are unable to pay. This gives rise to what is called "the law of addition."

Teaching the nomenclature of organic compounds may be made interesting by showing the similarity with human nomenclature. People and compounds may be distinguished by genetic or family relationships, by association characteristics, or by functional characteristics, etc.

Analogies from other fields of thought may be brought into teaching. Biological resemblance can be shown between amphoteric compounds

and hermaphrodites. Mechanostable resemblance can be shown between many geometrical forms and the chemical structure of compounds. Class spirit in man is like compounds which are soluble in their own kind.

It is believed that a chemical sense can be developed in students by repeatedly showing that all chemical phenomena are reflected in average human experiences, which are the common heritage of all types of humanity.

HOW TO TEACH CHEMISTRY: LIBRARY HELPS

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Calls often come from teachers in service for the names of helpful books and pamphlets upon the methods of teaching chemistry. In answer to such calls the writer has submitted the following. The list is in no sense exhaustive but represents a brief bibliography which he has found very serviceable with his classes for prospective teachers of chemistry in the University of Nebraska Teachers' College.

Author	*Title*	*Publisher*	*Date*
Brownwell and Wade	Science Teaching and Science Teachers	Century	1925
Com. on Natural Science	Natural Science Teaching in Great Britain	Bur. of Educ. Bul. 63	1919
Com. Reorg. Sec. Educ.	Reorganization of Science in Secondary Schools	Bur. of Educ. Bul. 26	1920
Com. Teachers Math. & Sci.	Bibliography of Science Teaching	Bur. of Educ. Bul. 446	1911
Cook	New Type Questions in Chemistry	Globe Book Co., New York	1927
Crane & Patterson	The Literature of Chemistry	Wiley and Sons	1927
Curtis	Investigations in the Teaching of Science	Blakeston	1926
Downing	Teaching Science in the Schools	Univ. of Chicago Press	1925
Frank	Teaching First Year Chemistry (Fourth edition)	Author, Oshkosh, Wis.	1927
Gerry	Harvard University, Bulletin of Education, No. IX	Harvard Univ. Press	1925
Glenn & Walker	Bibliography of Science Teaching in Secondary Schools	Bureau of Educ. Bul. 13	1925
Paterson	Preparation and Use of New Type Examinations	World Book Co.	1926
Powers	Contributions to Educ. No. 149	Teachers' College, Columbia Univ.	1924
Smith & Hall	The Teaching of Chemistry and Physics	Longmans	1902
Twiss	Science Teaching	Macmillan	1917

WHAT TO EXPECT OF THE HIGH-SCHOOL STUDENT IN CHEMICAL FORMULA AND EQUATION WRITING

O. L. BRAUER, STATE TEACHERS' COLLEGE, SAN JOSÉ, CALIFORNIA

There is need of a more exact definition of some of the objectives of high-school chemistry. By attempting too much teachers often fail to

TABLE I

Element or radical	University instructor would include		H.-s. teacher would include		Total	
	Yes	No	Yes	No	Yes	No
H^+	72		73		145	
Na^+	72		73		145	
K^+	72		73		145	
Hg^+	66	6	68	5	134	11
Cu^+	66	6	62	11	128	17
Ag^+	71	1	72	1	143	2
NH_4^+	72		73		145	
Zn^{2+}	71	1	72	1	143	2
Ca^{2+}	72		73		145	
Mg^{2+}	72		72	1	144	1
Hg^{2+}	68	4	70	3	138	7
Cu^{2+}	71	1	73		144	1
Fe^{2+}	71	1	73		144	1
Sn^{2+}	68	4	63	10	131	14
Ba^{2+}	71	1	69	4	140	5
Sr^{2+}	68	4	59	14	127	18
Al^{3+}	71	1	73		144	1
P^{3+}	61	11	65	8	126	19
Cr^{3+}	60	12	56	17	116	29
Fe^{3+}	71	1	73		144	1
Sn^{4+}	65	7	64	9	129	16
C^{4+}	69	3	71	2	140	5
Si^{4+}	67	5	67	6	134	11
P^{5+}	66	6	65	8	131	14
Cl^-	72		73		145	
Br^-	72		72	1	144	1
I^-	72		73		145	
OH^-	72		73		145	
NO_3^-	72		73		145	
HSO_4^-	68	4	67	6	135	10
HCO_3^-	69	3	70	3	139	6
S^{2-}	72		73		145	
SO_3^{2-}	72		70	3	142	3
SO_4^{2-}	72		73		145	
O^{2-}	71	1	73		144	1
PO_3^{3-}	71	1	71	2	142	3
PO_4^{3-}	60	12	56	17	116	29
SiO_4^{4-}	54	18	56	17	110	35
CO_3^{2-}	72		73		145	

develop desired skills in a large proportion of the class. The specific objectives dealt with in this paper are the writing of chemical formulas and equations. It is desirable from the point of view of brevity of expression, a clearer understanding of chemical reactions, and the working of chemical problems, that the pupils should develop a certain skill in writing formulas and equations.

In this study we have attempted to get a common understanding between high-school teachers and college instructors as to what should be expected of high-school pupils. With this object in view, we sent a questionnaire to a number of high-school and college teachers distributed over the United States. The questionnaire consisted of three parts; the first part listed 39 common elements and radicals with the valence indicated; part two listed 45 common and trade names of common substances; and part three listed 22 different kinds of chemical reactions. Using these as a starting point the teachers were asked in each case to scratch out and add to the list just what a high-school pupil should be able to use at the end of his course.

The response was very good, especially from the college and university instructors. We have replies from most of the outstanding professors in the large universities. There seemed to be a realization by all that we were attempting to supply a real need. This was shown by many lengthy comments and discussions. Knowing how busy these men are, we are greatly appreciative of their interest and trust that this article may lead to a clearer understanding of the beginning chemistry teacher's problems. There were 72 replies from university instructors and 73 from high-school teachers, who answered the questionnaire in detail. There were several replies in each class that did not answer the questions.

Table I contains the list of elements and radicals with the choice as to which should be required of the pupil in writing formulas. The student should be able to write any formula combining these radicals.

The following elements and radicals were not on the suggested list, but were written in by those answering the questionnaires.

Element	Univ. tr.	H.-s. tr.	Total	Element	Univ tr.	H.-s. tr.	Total
Pb^{2+}	9	6	15	Pb^{4+}	6	1	7
SiO_3^{2-}	2	5	7	Mn^{2+}	6	1	7
Mn^{4+}	6		6	ClO_3^-	1	5	6
$C_2H_3O_2^-$	1	4	5	NO_2^-	1	3	4
Sb^{3+}		4	4	As^{3+}		4	4
As^{5+}		4	4	MnO_4^-	1	2	3
Ni^{2+}	1	2	3	N^{5+}	1	2	3
N^{3+}	1	2	3				

TABLE II

Substance	Univ teacher		H.-s. teacher		Total	
	Yes	No	Yes	No	Yes	No
Lime	71	1	73		144	1
Table salt	72		73		145	
Caustic potash	70	2	73		143	2
Ammonia	72		73		145	
Caustic soda	71	1	73		144	1
Water	72		73		145	
Saltpeter	64	8	72	1	136	9
Chili saltpeter	68	4	72	1	140	5
Baking soda	72		73		145	
Washing soda	71	1	73		144	1
Charcoal	67	5	73		140	5
Diamond	72		72	1	144	1
Graphite	72		72	1	144	1
Lamp black	66	6	72	1	138	7
Coke	64	8	72	1	136	9
Quartz	68	4	68	5	136	9
Sand	71	1	73		144	1
Flint	53	19	54	19	107	38
Borax	62	10	65	8	127	18
Silica	70	2	72	1	142	3
Chalk	71	1	73		144	1
Marble	71	1	73		144	1
Limestone	71	1	73		144	1
Temporary hardness of water	66	6	71	2	137	8
Slaked lime	72		73		145	
Boiler scale	53	19	63	10	116	29
Stalactite	54	18	64	9	118	27
Quick lime	72		73		145	
Milk of lime	66	6	72	1	138	7
Whitewash	67	5	71	2	138	7
Plaster of Paris	67	5	71	2	138	7
Gypsum	65	7	72	1	137	8
Bleaching powder	63	9	70	3	133	12
Epsom salts	61	11	71	2	132	13
Cinnabar	52	20	54	19	106	39
Calomel	66	6	69	4	135	10
Corrosive sublimate	64	8	70	3	134	11
Iron rust	62	10	69	4	131	14
Alum	63	9	69	4	132	13
Emery	54	18	64	9	118	27
Chloroform	54	18	67	6	121	24
Alcohol	66	6	69	4	135	10
Soap	46	26	62	11	108	37
Sugar	52	20	70	3	122	23
Pearl	46	26	52	21	98	47

The following received 2 favorable votes: HSO_3^-, Bi^{3+}, CrO_4^{2-}, AsO_4^{3-}, F^-, $Cr_2O_7^{2-}$, Li^+.

This list received one vote each: S^{6+}, $S_2O_3^{2-}$, AlO_3^{3-}, Pt^{4+}, $C_4H_4O_6^{2-}$, Sb^{5+}, Cd^{2+}, CN^-, Co^{2+}, and Pt^{5+}.

This part of the questionnaire contained 39 suggested ions and elements. Among the university teachers, the maximum number of radicals and elements sent in by one person was 53 and the minimum 24. The maximum sent in by a high-school teacher was 46 and the minimum 23. The average for the university instructors was 38.97 and for those in high-school work 37.77.

It might be of interest to note the average number of radicals (radicals used as in Professor Kendall's Inorganic Chemistry, meaning both elements and radicals) suggested by those people who actually modified the original list, on the grounds that they studied it more critically, whereas the others might have accepted it as a general proposition, thinking a few more or less would make no difference. The average taken in this way shows 35.2 for the university teachers and the same for the high-school teachers. The results of Part I of the questionnaire show that as far as ions are concerned both classes of teachers are in accord. We should also conclude that the number of radicals should be between 35 and 39. A careful analysis of the replies shows that only 12 radicals received an unanimous choice, namely, H^+, Na^+, K^+, NH_4^+, Ca^{2+}, Cl^-, I^-, OH^-, NO_3^-, S^{2-}, SO_4^{2-}, CO_3^{2-}. If we added those which received only one adverse vote the list would be increased to 19 by the addition of Mg^{2+}, Cu^{2+}, Fe^{2+}, Al^{3+}, Fe^{3+}, Br^-, and O^{2-}. The adverse vote on most of the suggested list was remarkably low. Only three received a negative vote of over 13.1%. Of the radicals written in, Pb^{2+} only, received a vote worthy of mention, and although the vote, 15, is relatively small, perhaps we should add it to our list since it was not directly under consideration. Of the original list, perhaps we should reject Cr^{3+}, PO_3^{3-}, and SiO_4^{4+}. With Pb^{2+} this would give us 37 radicals on the accepted list, which would fall nicely within the limits as suggested by the vote. The list now reads as follows: H^+, Na^+, K^+, Hg^+, Cu^+, Ag^+, NH_4^+, Zn^{2+}, Ca^{2+}, Mg^{2+}, Hg^{2+}, Pb^{2+}, Cu^{2+}, Fe^{2+}, Sn^{2+}, Ba^{2+}, Sr^{2+}, Al^{3+}, P^{3+}, Fe^{3+}, Sn^{4+}, C^{4+}, Si^{4+}, P^{5+}, Cl^-, Br^-, I^-, CO_3^{2-}, OH^-, NO_3^-, HSO_4^-, HCO_3^-, S^{2-}, SO_3^{2-}, SO_4^{2-}, O^{2-}, PO_4^{3-}. This list gives us variety enough to write most of the simpler formulas.

Table II contains the vote on the common substances whose chemical formulas should be required of the students of high-school chemistry.

The following substances were added to the list by writing in:

	University	High school	Total
Wood alcohol		5	5
Methanol	1	5	6
Marsh gas	1	6	7
Sal ammoniac	2	5	7
Starch	2	5	7
Blue vitriol	7	10	17
Carborundum		7	7
Carbon tetrachloride		3	3
Vinegar	1	4	5
Glucose		4	4
Acetylene		3	3
Muriatic Acid	5	8	13
Peroxide	1	3	4
Carbona		3	3
Benzene		3	3
Ether		3	3
Bluestone		2	2

Formaldehyde, water glass, and sucrose each 2 votes by high-school teachers.

The following substances were written in once: sal soda, hematite, alumina, iron pyrites, lodestone, fluorspar, javelle water, silver tarnish, amyl alcohol, tin stone, chalcopyrite, zinc blende, pyrolusite, rayon, ink, fatty acids, copperas, sugar of lead, white lead, cream of tartar, boric acid, water gas, glass, zinc white, amino, lithopone, barytes, ethane, lye, chlorox, carbide, oil of vitriol, rubies, hypo, fire damp, after damp, pyrene, rouge, carbolic acid, precipitated chalk, stearin, palmitin, olein, cream of tartar, Rochelle salts, rock phosphate, levulose, glycerine. quick silver, aqua regia, nitro glycerine, chloride of lime, lunar caustic, methane, gems, explosives, Iceland spar, superphosphate of lime, alabaster, acetic acid, carbon dioxide, cellulose, corundum, magnesia, and galena.

A careful study of the ballots on this part of the subject shows the maximum number of common substances included by any one university instructor was 62 and the minimum was 22. The corresponding numbers for the high-school teachers showed 65 maximum and 26 minimum; incidentally, both extremes were submitted by women. The average number suggested by all the university instructors was 43 while the average for the high-school teachers was 44.6. If, as in the case of the first part of the questionnaire, we include only scratched ballots, the average for the university professors is 40 and that of the high-school teachers 44.5. This data would indicate that as a rule the high-school teachers attach more importance to knowing the formulas of common substances than do the university professors. Of the 45 substances submitted only 6 received an unanimous approval, namely: table salt, ammonia, water, baking soda, slaked lime, and quick lime. There were 131 different common substances suggested by the whole group. Due to the scattering of

votes, it is rather difficult to pick out an approved list. This divergence of opinion as to what are the important common substances, brings out the fact that the geographical location and previous training of the individual determine what he thinks important. The approved list must then represent substances common to all localities and touching every one's experience. These limitations will cut our list below the average number suggested by the replies. Of the substances written in on the list only blue vitriol with 17 votes and muriatic acid with 13 votes deserve consideration. If we take these two and all of the previous list receiving less than 20 negative votes, we have a list of 38 common substances as follows: lime, table salt, caustic potash, ammonia, caustic soda, water, saltpeter, Chili saltpeter, baking soda, washing soda, charcoal, diamond, graphite, lamp black, coke, quartz, sand, borax, silica, chalk, marble, limestone, temporary hardness of water, slaked lime, quick lime, milk of lime, whitewash, plaster of Paris, gypsum, bleaching powder, epsom salts, calomel, corrosive sublimate, iron rust, alum, alcohol, blue vitriol, and muriatic acid.

TABLE III

KINDS OF CHEMICAL REACTIONS TO BE REQUIRED OF HIGH-SCHOOL PUPILS

No.	Description	University		High school		Total	
		Yes	No	Yes	No	Yes	No
1.	Burning elements and C compounds	72		73		145	
2.	Replacement of H by metals from water and acids	72		73		145	
3.	Reduction of oxides by C and H	72		73		145	
4.	Volatile acids from salts and sulfuric acid	72		73		145	
5.	Halogens by oxidation of HX	61	11	62	11	123	22
6.	Direct comb. elements with Cl and S	70	2	73		143	2
7.	Prep. of oxygen heating potassium chlorate	72		73		145	
8.	Neut. any acid with any base	72		73		145	
9.	Dissolving metallic oxides and carbonates in acids	71	1	72	1	143	2
10.	Calcining hydroxides and carbonates	68	4	67	6	135	10
11.	Test for any chloride	72		73		145	
12.	Simple double replacements to equilibrium or to end	70	2	70	3	140	5
13.	Basic and acid oxides in water	70	2	70	3	140	5
14.	Dissociation into ions	71	1	71	2	142	3
15.	Hydrolysis of simple salts	62	10	69	4	131	14
16.	Oxidation of metals by nitric acid	54	18	65	8	119	26
17.	Dissolve zinc and aluminum and hydroxides in bases	53	19	57	16	110	35
18.	Slaking of lime	72		73		145	
19.	Removing hardness from water	65	7	71	2	136	9
20.	Heating of baking soda	69	3	72	1	141	4
21.	Replacement of metals	67	5	72	1	139	6
22.	Formation of stalactites and boiler scale	60	12	63	10	123	22

TABLE III (*Continued*)

Reactions written in:	University	High school	Total
23. Simple examples of electrolysis	3	2	5
24. Test for sulfate	1	15	16
25. Test for carbonate	1	7	8
26. Test for nitrate		6	6
27. Manufacture of ammonia and oxides of N		3	3

The following have two votes each by high-school instructors: reactions of charging the storage cell, reactions of discharging the storage cell, preparation of ammonia, and the test for calcium. The following were suggested by high-school instructors and have one vote each: test for the ammonium ion, test for the sulfide ion, test for the barium ion, nitric acid from the air, the Solvay process, saponification, blue printing, the manufacture of sulfuric acid, preparation of baking soda and washing soda, reactions of baking powder, metallurgy of common metals, preparation of starch in plants, preparation of soap, preparation of gasoline, decomposition of various nitrates, action of chlorine on water, and the action of iron on steam.

A study of the individual replies covering Table III shows that the highest number of type reactions reported by a high-school teacher was 44, and the lowest 17. The highest number suggested by a university professor was 26 and the lowest 12. The average of all of the high-school reports is 22.1, while the average for the university instructors is 20.2. The average of the forty high-school teachers who scratched their ballots is 22.2, while the average of the 41 college teachers who modified their lists is 18.9. This shows us unmistakably that there is a tendency for the high-school teacher to attempt more than is expected by the college instructor of freshman chemistry.

Any selection from the above list must be somewhat arbitrary. We would suggest throwing out the four from the original 22 with over 20 negative votes; number 5, halogens by oxidation of halogen acids; number 16, oxidation of metals with nitric acid; number 17, dissolving Al and Zn and their hydroxides in bases; and number 22, formation of stalactites and boiler scale, which would leave us 18 different kinds of chemical reactions. This list in its elaboration would be enough for the average class.

Some of the comment relative to this questionnaire is interesting. We will give a few extracts beginning with the unfavorable and ending with the favorable. First we will give extracts from university instructors:

1. "Your blanks concerning the teaching received and most carefully considered. Instead of filling out the blanks I beg to offer you a suggestion.

"Your apparent viewpoint in teaching chemistry is deadly dull. It is a routine and hack way of presenting such a subject. The teaching of chemistry lags far behind most other subjects and your questions seem to

indicate a wish to continue on in the old tiresome rut. The memorizing of formulas! How very futile and inadequate!

"I do not wish to ride a hobby or become a crank, but if I were compelled to teach chemistry as your questions indicate, I would prefer to go to the ancient languages, or something very, very dead.

"Yours very sorrowfully,"

In commenting on the above quotation, we were just wondering if the author would use *Popular Mechanics* as the text for his suggested variety of spineless chemistry.

2. "It is my belief that the high-school teacher can better stick to a few fundamentals and principles, the historical and descriptive parts of chemistry to the ultimate advantage of the student. . . I say, let the high-school course be general, drill on a few fundamentals and let the college course teach chemistry with all its details."

3. "In my opinion the greatest weakness of the teaching of chemistry in the high school is, as is evidenced by this questionnaire itself, that writing of formulas and equations is made the chief objective of the course. I confess to often having very grave doubts as to whether formulas and equations should be used at all in the first-year high-school course; certainly they should be used only as a means to the end of understanding what takes place, never as an end in themselves. This view of mine arises from the number of students I have come in contact with who enter college with the idea that chemistry is merely the committing to memory of a great number of equations, and for this reason having a great distaste for it."

In order to refute the implication that we would make the formal side of chemistry the main objective in secondary chemistry, we wish to refer to "The Chief Object of High-School Chemistry," *School Science and Mathematics*, **16,** 443–6 (1916). However, we realize the danger of making formulas and equations a burden to the beginner.

4. "The high school can most effectively teach its students *about chemistry*, rather than the technical details of it. In fact, I am myself rapidly coming of the opinion that the teaching of the specialized branches of science in the high school is doomed and that the future will see the development of a sort of synthetic science course including all of these branches and leaving for the college the differentiation."

5. "I would not like to say what should or what should not be taught in high-school chemistry but I would like to say this much that I would rather have students in Chem. I in college who *never had* chemistry than the majority of those who have had it. High-school chemistry if taught as an inspirational course and as explanations of everyday problems is all right, but if taught for subject matter only or in a large part, I consider

it a waste of time. I feel that high-school chemistry has a place in the field of inspirational courses and as a course in which the scientific attitude of mind and method of analytical thought are taught but I would not indorse a subject-matter course in chemistry in the high schools."

The foregoing quotations represent a rather complete list of those replies that could be interpreted as being in any way adverse to the intent of our questionnaire. The writer of this article has taught in both high-school and college. It is our firm belief that a purely inspirational course with no real chemical technic does not challenge the mind of the student, and as a result loses his respect. He soon classes it with the snap courses that can be bluffed through with a minimum of study. In our twelve years' experience in teaching high-school chemistry we have found that there must be a certain number of specific objectives, so that the students may know that they are really doing something, and know what the task really is. Our experience with students in college chemistry is quite different from that of some of the foregoing quotations. We find a marked contrast between those students who have had high-school chemistry and those who have not. It is almost a superhuman task for those who have not had chemistry to keep in the same class with those who have. Perhaps the students who have had high-school chemistry and who do not do as well as those who have not had it, as mentioned in quotations 1 to 5, are some who have had a so-called inspirational course.

The favorable comments on our questionnaire far outnumber those quoted above, but space will allow us to quote only a few.

6. "This is an excellent nucleus though not without some slight modification."

7. "These seem very good to me. I like especially the statements in the third paragraph of your letter."

8. "I think your idea splendid. I have underscored the items I consider of great importance to high-school graduates who enter college. Undoubtedly they should know most of the reactions named above."

9. "I think you have presented a good sound list of specifics. In addition I should like to have you get an expression from teachers as to the amount of new chemistry which should be included in such a course. . ."

10. "I think this is a good list. More attention should be paid to writing equations. I find few students can write even the simple ones."

11. "I believe the outlines which you have sent me and which I am returning to you are eminently satisfactory to serve as a minimum requirement for high-school work. Personally, I am not one who believes in insisting that the high-school students actually learn much more than these minimum requirements. The rest of the time should be spent in putting the student in touch with things chemical which are interesting or inspiring and which he is not expected to learn."

The high-school teachers were not given to comment to the same extent as the college teachers, yet there are too many to quote more than a few representative ones.

12. "Your statement, 'We are attempting to arrive at a common ground that will represent the consensus of opinion of both high-school teachers and teacher of freshmen chemistry in college' is very commendable."

13. "These are all good, and the student should be familiar with them. I believe in great stress on valence, formulas, and equations."

14. "Although these objectives should be the goal sought for, in my ten years' experience I have never been able to have a class *as a whole* that was able to be proficient in handling them."

15. "I think that your summary of the year's work given above is very complete and is no more than the average student should be able to do. My pupils must be able to do this much before they will receive a high-school unit in chemistry and they must be able to do more than this if they are to receive a college unit in the subject."

16. "These are the principles which I in my old-fashioned way am still stressing and drilling on. I am not yet converted to the idea of presenting the subject from the *purely 'Appreciative Course' viewpoint.*"

17. "I have tried the above list with my students and several gave all correct except 'whitewash.' My class should write all the formulas with the elements and radicals given above."

The replies show that our attempt to define definite objectives in chemistry is a move in the right direction. We trust that the selection of objectives from the lists will serve a useful purpose to high-school teachers.

As a supplement to this article we will give some incidental data relative to the training of high-school and college teachers. Of the university teachers who stated their degrees, 53 had Ph.D., 2 D.Sc., 15 M.A. or M.S., and 2 B.A. The high-school teachers were distributed as follows: 2 Ph.D., 24 M.A. and M.S., 1 Ph.B., 1 C.E., 45 B.A. and B.S.

Health Experts Compute Sunlight Losses from Smoke. Manhattan's great smoke screen cuts out 42 per cent of the morning sunlight that is every Gothamite's just due on winter days. At noon the loss is 18 per cent. The figures for this indictment of the smoke nuisance in large cities have been compiled by experts of the U. S. Public Health Service. Loss of efficiency from decreased lighting is not the only result of excessive smoke in manufacturing centers, they maintain. It also cuts out to an appreciable extent the ultra-violet rays necessary for good health.

The importance of getting rid of smoke is emphasized for the preservation of eyesight and health generally, as well as prevention of accidents. On foggy days the loss of light runs even higher than the figures quoted, it was stated.—*Science Service*

THE RELATION OF THE FOREST MANTLE TO THE TEACHING OF CHEMISTRY IN SECONDARY SCHOOLS*

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The fixation of industry is a well-established fact. Although the largest supplies of iron ore are in Minnesota, the iron industry is centered in Pennsylvania. Akron, Ohio, continues to be a great rubber center with Los Angeles destined to become a similar center on the Pacific Coast. The recent establishment of numerous pulp mills in Oregon and Washington seems to assure the Pacific Northwest of a fixed position as a center of this industry. Closely associated with it are industries of an electrochemical character such as electrolytic chlorine and soda. The present abundance of pulp wood and its permanency due to reproduction in a generation, made possible by climatic causes and the great quantity of available water power likewise due to climatic and topographic conditions constitute a basis for the present and future development of these industries.

It is possible, therefore, to visualize the chemical activities of our state in future years. The conversion of water power into commodities, such as in nitrogen fixation and the products of electrolysis, is already established. The conversion of the forests into lumber utilizes less than one-third of the forest growth that is harvested. The use of the other two-thirds is dependent upon the application of chemistry to industry. From the forest mantle that everywhere covers our hills and mountain slopes may also be obtained charcoal by destructive distillation, tannin by extraction of hemlock bark, turpentine and rosin from resinous fir, alcohol and carbohydrates from sawdust, chemical pulp from hemlock, spruce, cottonwood, and fir. These industries are of tremendous economic interest already manifested in the erection of manufacturing plants in almost every center of population. It is pertinent to ask the question: Shall the high-school graduate be equipped with an understanding of the industries into which he eventually will most likely turn for opportunity and service? Our answer is that we have long recognized the possibility of such preparation for service in other lines of activity. Our courses in agriculture, manual training, and home economics have largely contributed to the better equipment of boys and girls for service on the farm, in the mechanic arts, and in the home.

It is not the intention to make a plea for a specialized course in chemistry. It is recognized that the high-school curriculum must function in providing mental discipline and a preparation for scientific training. In it chemistry holds a foremost place in the development of precision of thought. Nevertheless, the time has come in our social and economic

* Address before the Washington State Chemistry Teachers' Association, Longview, Wash., October 28, 1927.

development to consider also the vocational viewpoint of chemistry. In these days when well-trained technical graduates of colleges are glad to accept jobs at $6.00 a day, while their former playmates are employed at $12 to $15 a day as plumbers, carpenters, or brick layers, it seems especially timely to adopt an attitude of correlation of chemistry with the industries dependent upon it. It seems to the writer that this can be brought about without sacrificing its disciplinary value and yet give our future citizens an appreciation of the properties of the matter with which they will be concerned in their daily work.

For some years the writer has given a single semester course in chemistry to girls entering upon hospital training. At first, the object was merely to provide these students with the vocabulary of chemistry; an understanding of its fundamental laws and the meaning of the chemical equation, so that in their subsequent studies and reading of professional journals chemical terms might not be like foreign language phrases in literature. But gradually we found it possible to organize these courses with the subject-matter largely drawn from hospital practice and yet not diminish one whit the real significance of chemistry as contained in the orthodox matter usually covered in one semester. A test for chlorides and phosphates in milk or hamburger steak is just as good a test as though the material had come from a bottle from the laboratory side shelf. The laboratory exercises dealing with carbohydrates, fats, proteins, digestion, blood, urine, etc., are just as vital for instructional purposes as are those dealing with "nitrogen and ammonia, nitric acid and the oxides of nitrogen, phosphorous and its compounds, sulfur and its compounds, etc." Not long ago the writer visited a sugar refinery where fifteen girls, former high-school chemistry students, were employed in making hydrogen-ion determinations. Recently, the executive of a pulp mill asked for a list of high-school chemistry students for employment in making titrations of sulfite liquor in the digesters. It is the experience of these plants that these high-school lads and lassies do as accurate work as is done by college professors.

The adaptation of chemistry instruction in our secondary schools to its actual service in the industries of the state or community is not any more difficult than similar adaptation of other portions of the curriculum to which reference has already been made. It does call, however, for a departure from the conventional or standardized chemistry instruction we have been practicing. It calls for a scheme of instruction in applied chemistry. It requires the substitution of the evaluative method for the purely qualitative physical observation. It is not a difficult matter for a student to observe that when the products of combustion from burning hydrogen are condensed, water is formed. It is not any more difficult to evaporate a quantity of water to dryness on a water-bath and note the difference in the nature of the total solids of a polluted and an unpolluted

water. As before stated the chloride test for sewage is not any more difficult than for the sideshelf reagent, but it becomes a basis for the use or non-use of a given water supply.

This functional viewpoint is essential to the relationship of our chemistry instruction to our industries. It matters but little whether the subject matter be the compressed gas industry, the fuel industry, or the pulp industry. As long as the evaluative viewpoint is stressed in a portion of the chemistry course and the student catches a glimpse of how chemistry functions in industry it will produce a very vitalizing effect in the curriculum at this point. It will not detract from the preparation of the student for entrance into college. It will make citizens see more clearly the real facts involved in agriculture, in sanitation, and in manufacturing industries. Surely it will make the operation of living at least more interesting.

Alcohol Chief Poison in Bootleg Liquor. The principal poison in post-prohibition liquor is alcohol, in the estimation of Dr. H. V. Atkinson of the department of pharmacology at the State University of Iowa.

"An examination of the evidence, which from the nature of the problem is far from exact," he declared in a recent report to the American Pharmaceutical Association, "seems to prove that most cases of poisoning as a result of drinking bootleg liquor are due to the ingestion of an over-dose of ethyl alcohol."

Dr. Atkinson divides liquor, as it is known today, into three classes: properly made whisky and brandy, synthetic liquors, and moonshine or home-brew liquors.

The first class is in all respects the same as carefully made liquors in pre-prohibition days and has never been seriously suspected of containing anything toxic besides the alcohol that makes people want to drink it, stated the chemist.

"Acute poisoning as the result of drinking bouts," he added, "has long been known and is not surprising since the concentration of alcohol in the blood depends on the concentration of the alcohol in the liquor used and the rapidity of ingestion. The margin between the concentration of alcohol in the blood required to produce intoxication and that causing collapse is not great."

Poisoning from synthetic liquors may be due to any one of a large number of substances used to denature alcohol. Wood alcohol is the guilty agent in most cases but poisoning has been reported from such compounds as nitrobenzene. These are rare, however, the chemist declared, or have escaped detection.

The third class contains those that are fermented and distilled surreptitiously. The great drawback to this type of liquor is the inclusion for reasons of financial profit of "heads" and "tails," the first and last runnings, respectively, of the distilling. Moonshiners in the old days learned from sad experience that the heads and tails should be thrown away. The former contain certain chemical compounds deleterious to the human system while the latter contain fusel oils, too widely discussed to need explanation. Continued use of badly made moonshine has been shown to produce bad effects on the kidneys of animals.

A few cases of lead poisoning from the solder in the distilling apparatus have been reported, while poisoning from the copper of the still is likewise a remote possibility pointed out by Dr. Atkinson.—*Science Service*

INTENSIVE TRAINING IN CHEMISTRY*

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Superior work and a smaller percentage of failures observed in connection with intensive instruction in chemistry during summer sessions have prompted the writer to note his observations for the benefit of others who are interested in the teaching of chemistry.

Before taking up the results of this intensive instruction it may be well to consider the effects of segregation on the basis of preliminary training in high schools. During the college years 1921–24 inclusive, all students were given the same course in general chemistry irrespective of preliminary training. The results are indicated by the solid lines in Figures 1 and 2. During 1925 and 1926 students were placed in separate classes, those having had chemistry being given more advanced instruction and a different textbook. The results for students who had no high-school preparation are indicated by dashes and for those who had high-school preparation by dotted lines in Figures 1 and 2. It will be observed that a greater number of students did superior work as the result of the segregation and that there were fewer failures. This observation leads the writer to believe that the distribution of students according to preparatory training is certainly a desirable step in advance of the older method of having all students take the same chemistry course.

Next, a comparison is made between the interrupted college course in general chemistry and the intensive summer course. During the college year the student has one or two lectures per week, two recitations or one, together with a four-hour laboratory period depending upon whether he has had high-school chemistry or not. It is found that fewer lectures are necessary for those who have had high-school preparation. These students are scheduled for seven hours per week during the seventeen weeks of the semester. The summer students work from 8.00 to 1.00 daily, six days per week, for four weeks to cover a semester's work. During the college year students carry three or four subjects besides chemistry. During the summer they are not permitted to register for anything but chemistry and while they devote the five morning hours to lecture, recitation, and laboratory work, the afternoons and evenings are free for study and recreation. They have no subjects to think about except chemistry. The results for the first and second half of the course are shown in Figures 3 and 4, respectively. In these diagrams, records from 1921 to 1927, inclusive, are considered. It will be observed that students do superior work during the summer sessions and that there is a much smaller number of low grades and failures.

* Presented before the Division of Chemical Education at the 74th Meeting of the American Chemical Society, Detroit, Mich., Sept. 7, 1927.

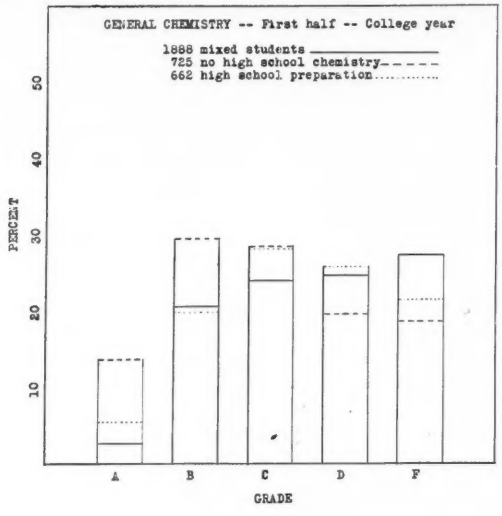

FIGURE 1

To ascertain whether this tendency prevailed in more advanced courses where large numbers of students were taught, statistics were also con-

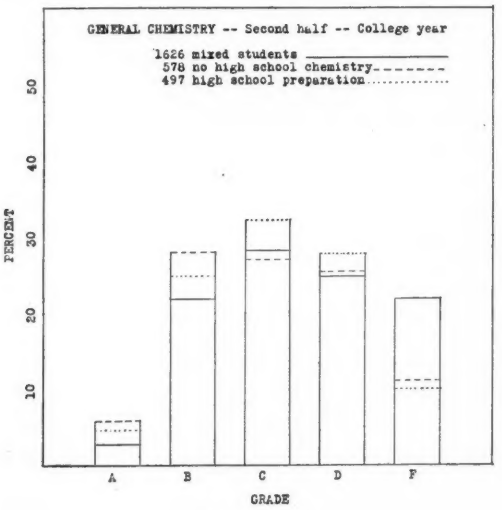

FIGURE 2

sidered for organic chemistry. Here (Figures 5 and 6) it will again be observed that there is a greater proportion of superior work during the summer and a smaller number of low grades and failures.

In the various diagrams presented, the numbers of students indicated are the totals for the entire periods mentioned in the foregoing paragraphs. The grade *A* indicates a record of 90 to 100; *B*, 80 to 90; *C*, 70 to 80; *D*, 60 to 70; *F*, below 60. Included with *F* grades are students who withdrew from time to time but who had failed before withdrawing.

The reader may feel that the smaller number of students taught during the summer session insures closer personal contact between the student

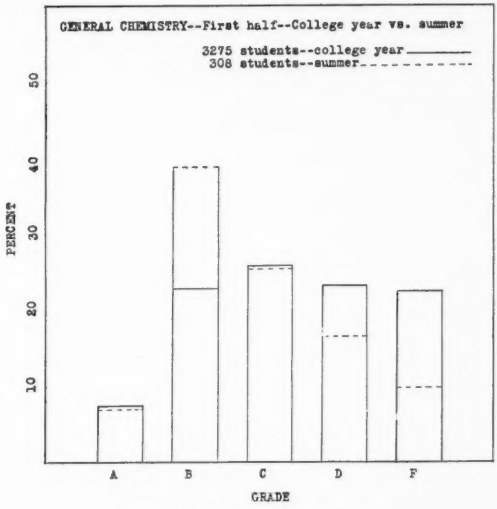

FIGURE 3

and the instructor and that this is responsible for the superior showing. The laboratory and quiz sections taught during the summer were equally as large as those scheduled during the college year, so this factor is eliminated.

The writer finally advocates intensive instruction as a means towards superior work and the lowering of the number of failures. If this plan can be properly coördinated with the teaching of courses other than chemistry it should prove a step in advance of our present method of instruction. In an earlier paper[1] selective instruction was advocated. The teaching of students in small groups according to individual or group ability and the advancing of students according to this ability in a par-

[1] *Ind. Eng. Chem.*, **16**, 860 (1924).

ticular group can be applied to either of the above methods of instruction, further increasing the number of superior students and lessening the number of poor workers and failures.

It is self-evident that selective instruction will cost more than the interrupted or intensive methods. The superior results would justify the added investment. Even better results could be obtained were our colleges and universities able to afford the employment of more mature and experienced teachers instead of placing so much responsibility upon

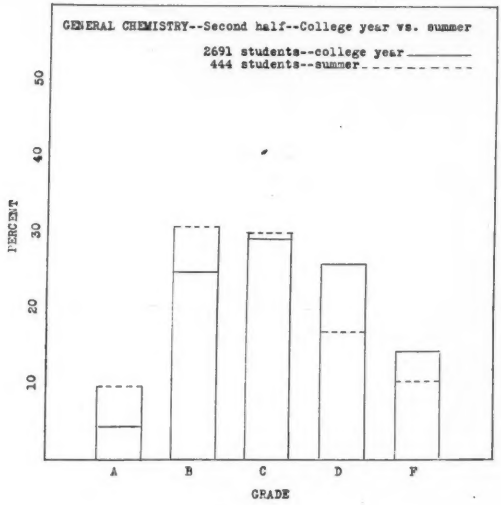

FIGURE 4

undergraduate or graduate assistants. Mature experience is just as essential in the giving of laboratory instruction as it is for lecturing.

Conclusions

1. Mixed classes in general chemistry result in a larger number of poor records and failures than where the students are segregated on the basis of preparatory training.

2. Intensive instruction yields a higher percentage of superior grades and fewer low grades and failures than the interrupted training ordinarily given in colleges and universities. This is true for both elementary and more advanced classes.

3. Teaching in small groups on the basis of the student's ability to

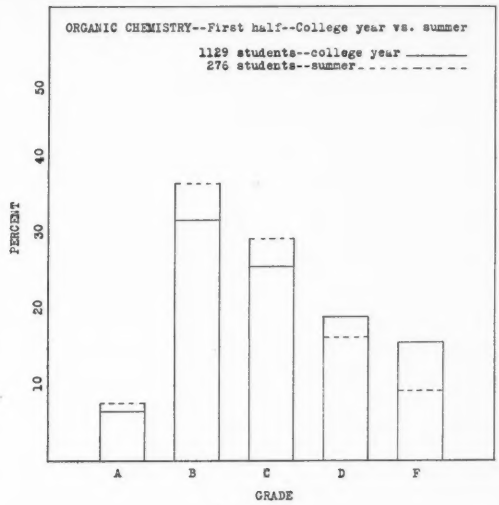

FIGURE 5

progress should further increase superior work and lessen inferior work and failure.

4. The employment of a greater number of mature and experienced

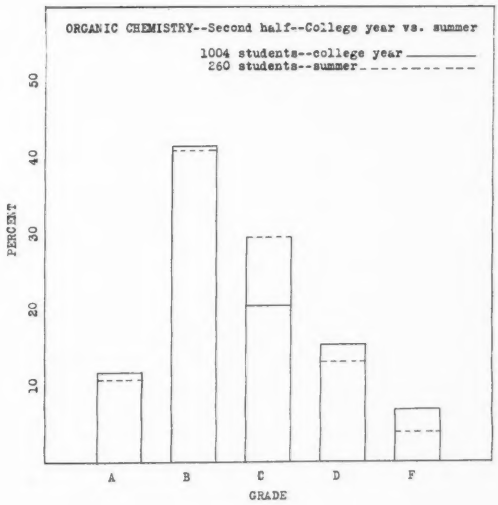

FIGURE 6

teachers will also raise the standard of instruction and yield even better results.

5. Any or all of the improvements suggested are dependent upon the facilities and funds available.

Ultra-Violet Rays Increase Mineral Salts in Plants. Ultra-violet rays used to prevent the bone disease rickets in young children and animals by raising the calcium and phosphorus content of the blood have a parallel effect on plants. This is indicated by the results of experiments by Herbert C. Beeskow, a graduate student at the University of Chicago.

Mr. Beeskow grew groups of soy-bean plants in solutions of known mineral composition. He subjected different groups to ultra-violet radiation for varying periods of time, keeping other groups away from the rays as "controls." Then he dried the plants and analyzed them for calcium and phosphorus. In each case it was found that the irradiated plants had noticeably higher contents of these important minerals than the corresponding un-rayed controls.

The effects of irradiation with ultra-violet light were not all beneficial to the plants. Soy beans grown in the greenhouse and subjected to direct ultra-violet raying for as short a period as one minute every other day showed a distinct reddening in the parts of the stem and leaves struck by the rays. This coloration increased with increases in dosage. In cases where the under side of the leaves was exposed to the rays the reddening action was much more in evidence.

Plants grown in darkness and subjected to the rays showed this red color much more distinctly than plants grown in daylight and permitted to become normally green. Heavy overdoses of the rays simply killed the plants.—*Science Service*

Bright British Boys Are Also Best Athletes. The boys that win scholarships to Oxford and Cambridge are not "greasy grinds" interested in trigonometry and Latin alone, but are as good athletes as they are scholars, recent investigations show.

Dr. A. H. Mumford, medical officer of the Manchester Grammar School, recently reported to the Royal Anthropological Institute that boys winning first class honors exceeded the average in acceleration in growth of chest girth, height, and weight and have a slightly better physical frame.

A list drawn up of boys who had been awarded "colors" for prowess in football, cricket, swimming, running, and the like showed that there were about 700 chances for exhibiting special physical excellence among 7000 boys. Seventy-three of the 700 awards were won by 215 boys of special mental ability. This means that the best students took about one-tenth of the athletic honors and that one boy in three of the mental "sharks" was also a good athlete.

The degree of mental excellence seemed to be fairly proportionate to the degree of physical excellence. Out of the 73 athletic awards achieved by this group, 45 went to the 27 winning first class honors, 18 to 14 boys in the next group, and only 9 to the 6 boys in the third group.

These figures, Dr. Mumford asserted, tend to show that the growth of the human frame should be viewed as a unity and not as one of mind or body alone. The records of the scholarship winners indicated that they can maintain a high level of work with less strain as the result of the combination of high mentality with superior physique.—*Science Service*

WHAT A SUMMER-SCHOOL COURSE IN CHEMICAL ENGINEERING CAN ACCOMPLISH

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Chemistry has become the science of the age since it has absorbed the better part of physics. The application of this science under the name chemical engineering is fast becoming the leading engineering subject of modern times. This is because of its tremendously broad background of science. A few years ago there were only a few so-called chemical industries; today any industry that involves a chemical or chemical engineering process is considered a chemical industry. In value of output a fifth of all of our industries come under this definition.

Universities wherever able should offer courses covering the latest developments in our chemical industries together with the fundamental principles of chemical engineering. This course should be offered for the benefit of both teachers and men in industry who maintain their interest in the progress of science and industry. In some of our universities, summer-school courses offer a popular means of keeping these men abreast of modern developments.

First of all, in any such curriculum there should be offered a thorough course in the principles of chemical engineering as outlined in Walker, Lewis, and McAdams' famous textbook. To be more specific, the principles of chemical engineering are now considered to be the methods used in applying chemical and physical theory to the so-called "unit operations," which are, for example, combustion, grinding, filtration, evaporation, humidification, drying, distillation, absorption, and extraction. These principles have been developed only a few years ago. This means that a vast majority of our teachers, both in high schools and colleges, are unfamiliar with the modern methods of applying chemical and physical theory to industry. Unfortunately, it is not a subject that can be studied satisfactorily without experienced guidance. The course should be given by one who has a thorough knowledge of the text and whose broad, personal experience is sufficient to give a correct viewpoint of details. A laboratory course should be given in order to fix the subject in the student's mind. Test runs can be made on all kinds of standard-sized or semi-works equipment; for example, stills, rectifying columns, evaporators, condensers, grinders, crushers, filter presses, dryers, etc. These tests are to determine efficiencies, capacities, and general suitability for a given purpose.

The men who are to-day largely responsible for the great developments in industry find specialization along certain lines is not enough. They find it essential to know something of many subjects that are not, strictly speaking, chemistry or chemical engineering. An example would

be chemical engineering economics which has recently been brought to the attention of the public by Tyler's admirable text. The great developments of industry are based on sound economics. No elementary course on the general subject fills the need. It becomes necessary to offer the methods of application of general economic principles to this particular profession. It proves to be, fortunately, an interesting and fascinating study.

The A B C of our patent laws and regulations, a subject of which the average scientist knows nothing, is not a dull subject. The knowledge of the why and wherefore of patents has prevented many a serious financial catastrophe and oftentimes has meant vast profits to the possessor. Unquestionably, a course should be offered which would furnish the student with the essential facts concerning chemical patents and patenting.

Today it is not necessary to have enormous laboratories with vast equipment and countless expert assistants to make truly great chemical inventions of world significance and financial importance. The initial idea and the preliminary experiments are often made under very economical conditions. It is true, however, that men and money are often needed to develop these inventions to a point where the public can be benefited. Unfortunately, the general methods used by our great industrial laboratories to produce these ideas are never published. It would surprise many to learn that there are well-defined methods of attack which are used consciously or unconsciously by research workers everywhere to solve a specific type of problem. Many geniuses are, if the truth were known, merely men with a thorough knowledge of the basic facts coupled with a knowledge of these methods of procedure. It, therefore, becomes necessary for a university to offer a course giving in detail these principles of research used in our chemical industries illustrated by actual examples of great developments. Problems should be given so that the student may perfect himself in these methods. It has been found by actual experience with such a course at the University of Illinois that the average student not only becomes intensely interested in the subject but also produces inventions, after a few tries, that have some industrial significance.

Chemical technology laboratory courses have become popular in at least one university summer school because they have given the student a real opportunity to experience the sensation of becoming an actual designer and operator of semi-commercial plants. This course gives the student the thrill of large-scale accomplishment. It gives him also a genuine appreciation of the plant operator's and the plant designer's difficulties. The student realizes, perhaps for the first time, the pressure of production, the importance of chemical engineering economics, and the limitations of large-scale equipment. This knowledge is of great impor-

tance to the teachers and research workers as well as the future plant man. In fact, too much cannot be said in favor of this course.

Certain summer-school courses in chemical engineering have become of great importance especially to teachers of chemistry. These courses interest the student because they give him an intimate picture of our great modern developments.

Cod-Liver Oil Fails As Egg Stimulator. Cod-liver oil and ultra-violet light do not seem to have the happy effect on the egg-laying capacity of hens in Great Britain that they have had in America.

The value of ultra-violet light in practical poultry farming has been tried out by Eric W. Mercer and Dr. F. H. W. P. Tozer at the poultry farm of the Berkshire and Buckinghamshire Joint Sanatorium, which produces about 36,000 eggs every year. The experiments were carried out in winter, but conditions were planned so as to allow the hens free access to open air, sunlight, and grass. The diet was good, with plenty of greens, but the supply of vitamin D was purposely kept low. Six control hens were kept on the basal diet, and four experimental sets (of six hens each) had the basal diet with various additions. In each case, records were made of the number of eggs laid in eleven weeks.

The results showed, however, that in each group of experimental hens less eggs were actually laid than by the controls. From this experiment the investigators concluded that poultry keepers who keep their birds under proper open-air conditions with suitable food and plenty of green stuff will gain no benefit by feeding cod-liver oil or irradiating either the fowls or their feed.—*Science Service*

Coating on Vacuum Tube Filament Helps Electrons Escape. How a thin layer of atoms of cesium on the filament helps the vacuum tube of a radio set to work better was described to the American Physical Society, recently, by Dr. J. A. Becker of the Bell Telephone Laboratories in New York. Dr. Becker told of work that he had done in collaboration with D. W. Meuller of the same Laboratories.

The operation of a radio tube, he explained, depends on the copious emission of electrons from the hot filament. When coated with cesium, in the form of cesium oxide, the atoms of the metal arrange themselves over the filament in a single layer. But the atoms are ionized, which means that each of them has lost one of its quota of electrons and so is positively charged. This atomic layer is then able to act in the same way as the grid of the tube, but being so close to the filament is particularly efficacious in pulling the electrons out of the tungsten of which it is made.—*Science Service*

X-Rays Make Crystals Glow. Another newly discovered effect of x-rays, by which they impart to certain chemical substances the power of glowing when slightly heated, was described to the meeting of the American Physical Society, recently, by Dr. Frances G. Wick of Vassar College. Dr. Wick told of work that she had done in collaboration with Miss Mabel K. Slattery, research assistant at Cornell University.

Some substances, such as fluorite and calcite, have long been known to possess the property of shining in the dark after being moderately warmed, she stated. However, the investigators have found that chemicals which do not have this power acquire it when exposed to x-rays. One of these is calcium sulfate, of which gypsum is a form, mixed with a little magnesium. The phenomenon is called thermoluminescence and is of two kinds, it was said. One dies out quickly, but with the other, the power to glow when heated may continue for months.—*Science Service*

THE NEED FOR STANDARDS IN COURSES IN THE TEACHING OF CHEMISTRY

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A study of courses in Methods of Teaching Chemistry made in 1926[1] disclosed the fact that 72 courses given in the various colleges and universities showed little uniformity in subject-matter offered, credit given, or in any other feature.

In the summer and fall of 1927 the writer attempted to gather more specific information regarding the courses in the Teaching of Chemistry than had been given in Miss Hayden's report. By tabulation of catalog descriptions, through correspondence with teachers giving the courses, and often by a study of notebooks and actual outlines descriptive of the course, much specific information was obtained regarding 22 summer-school and 20 regular session courses. As in the case of courses in the teaching of the other sciences, an astonishing lack of uniformity was shown. So very few features reappeared with any appreciable frequency that a quantitative summary was hardly possible. The outstanding facts relating to the 42 courses studied seem to be about as follows:

Types of Courses

The courses were of three general types:

(*A*) A course usually given by the Department of Education, which stressed modern educational theories and practices, but which gave little attention to the specific problems of the chemistry classroom.

This type of course has often been disappointing to teachers who claimed that the subject-matter offered was too theoretical and not capable of application in the solution of the teacher's most difficult problems. In some cases, this course has not been favorably looked upon by the department of chemistry.

(*B*) A course given by the department of chemistry, usually devoting much time to the more difficult phases of the subject-matter of general chemistry, giving only passing attention to modern educational theories and practices.

Often this course has been just an additional subject-matter course. Frequently, when some treatment of methods was attempted, that part of the course consisted of a discussion of college methods as the instructor thought they might be applied in the high school.

(*C*) A type of course given either by the department of education or the department of chemistry—but which gave no undue emphasis to either field.

[1] "Methods Courses: Survey of Courses in the Teaching of Chemistry." Henrietta Hayden, THIS JOURNAL, **3**, 528–32 (May, 1926).

This course has usually been planned and given by instructors who were thoroughly acquainted both with theories and practices in secondary education and with the field of general chemistry. In some instances, these instructors have had experience as high-school teachers of chemistry and their courses have been planned and given in such a way as to win the complete sanction of both the department of education and the department of chemistry.

It is evident that the latter type of course ought to be the superior course.

It should be said that nearly all of these courses have had a fixed content. They have been organized and given as set courses. Students might take them or not, as they saw fit, but no changes would be made to fit the needs of any particular class. There have been instances in which an entire class of mature teachers, in order to get a part of the content in which they were interested, had to sit through many days or even weeks in which material useless to them was presented by an instructor who had something he wanted to teach though he was oblivious to the fact that the members of the course had no interest in it. While the materials treated might have been just the thing for some classes, no survey of class needs had been made and the instructor knew very little about the members of his class and what they wanted.

CREDIT GIVEN

The usual credit is 2 semester hours. In a few cases 3 or 4 hours of credit are given for the course.

REQUIRED STUDENT ACTIVITIES

Wide variation is shown. Some courses merely require attendance at lectures, and depend upon a final examination to determine student accomplishment. Others include combinations of various additional activities as follows:

1. Study of texts.
2. Reading of literature relating to chemistry teaching.
3. Laboratory work in chemistry.
4. Special reports.
5. Term papers.
6. Preparation of courses of study.
7. Practice teaching.
8. Class discussion.

PREPARATION OF INSTRUCTORS GIVING THE COURSE

Varies widely.

(*A*). Some are well versed in educational theories, but not acquainted with the field of chemistry.

(*B*). Some instructors know chemistry but are not acquainted with the theories and practices of modern secondary education.

(*C*). A number of instructors are plainly thoroughly acquainted with modern educational methods and also with the field of chemistry. In addition, some of them are experienced high-school teachers.

LEVEL OF COURSES

Courses are undergraduate, undergraduate and graduate, or strictly graduate.

In summary: Courses in the teaching of chemistry are not at all in agreement in aims, level, materials offered, required student activities, nor the preparation and outlook of instructors giving the course. The only approach to uniformity is in name and credit given. The large majority of the courses are called "The Teaching of Chemistry" and carry 2 semester hours of credit.

Bad Effects of Lack of Standardization

The wide variation in everything relating to the course in the teaching of chemistry results in a number of bad effects:

1. Since the content and level of the course is not in any way standardized—students have difficulty in transferring credit from one school to another. Some schools accept the course in methods, but refuse to credit the subject-matter course on the ground that it is largely a duplication of the course in general chemistry.

2. Teachers find it difficult to take a progressive sequence of courses because neither the name nor the content suggest any sequence—though teachers, undoubtedly, need both subject-matter and methods courses.

3. In the absence of any standards to indicate content, instructors often ride their own particular hobbies to the loss of the students taking the course.

4. Because both the subject-matter course and the methods course carry the name "The Teaching of Chemistry," many teachers take but one course though they may need both. Only one course is taken because no school will give credit for two courses carrying the same name.

Suggested Remedial Measures

It is suggested that considerable advance might be made if the colleges and universities were to offer two distinct courses for chemistry teachers.

(*A*). A course called "Chemistry for Teachers" or "Teachers' Course in Chemistry" to consist mainly of a review of the most difficult phases of the subject-matter of general chemistry. A professionalized subject-matter course. This ought to be an undergraduate course and ought to include some laboratory work. Given by the department of chemistry. 3 credits.

(*B*). A course called "The Teaching of Chemistry" to deal mainly with such topics as the selection and arrangement of subject-matter, texts, tests, methods, etc. This course ought to be of graduate level; with course (*A*) or at least two years of experience in teaching chemistry as a prerequisite. Given by the department of education. 2 credits.

Objectives

Course (*A*) would be intended chiefly to develop in the prospective teacher a thorough understanding of the subject-matter of chemistry, which is generally conceded to be the first requisite for good chemistry teaching. Of course, most schools are not ready to admit that their advanced students in chemistry do not have a thorough understanding of the fundamentals, but the demand for subject-matter courses and the experience of teachers giving such courses clearly indicate that graduate students and experienced teachers often are badly in need of instruction in the fundamentals of chemistry. Some schools, hesitating to admit the above facts, give this course in subject-matter, but call it "The Teaching of Chemistry."

Course (*B*) would assume that the student is thoroughly familiar with the subject-matter of chemistry. This course would deal with the problems of instruction in chemistry from the educational point of view. It would have a long list of objectives and would be adapted to the actual classroom needs of teachers of chemistry. Since this course suffers the greatest variability, a list of suggested objectives and a tentative outline of the course is offered with the thought that it might serve as a basis of discussion and a point of departure for those who are preparing courses of this type. It may be possible to offer a similar outline of a course of the subject-matter type at some later time.

The Ultimate Objectives of a Course in "The Teaching of High-School Chemistry"

The value of a course in the teaching of chemistry must be measured in terms of the understandings, abilities, ideals, perspectives, attitudes, and the like, which it induces in the members of the course, and the desirable changes wrought in their teaching. The ultimate objectives are, then, the production of these ideals, abilities, attitudes, understandings, and the like. An analysis of the ultimate objectives seems to indicate the validity of a number of intermediate objectives, as follows:

1. To give the orientation, perspective, and the background required for an intelligent study of the problems involved in the teaching of high-school chemistry.
2. To define the more important problems of chemistry teaching.
3. To describe and study the more fruitful methods of educational

investigation, and evaluate the usefulness of each in solving the problems of chemistry teaching.

4. To show the limited value of opinion and to develop an appreciation of the permanent value of the findings of properly conducted research.

5. To open up new interests in the field of chemistry teaching.

6. To acquaint the student with, and interest him in the more important literature relating to science teaching, and in the men and institutions which have produced it.

7. To present, discuss, and evaluate the current methods and plans for teaching chemistry.

8. To present and evaluate the various materials and devices used in teaching or enriching the course in chemistry, such as: books and other literature; tests; apparatus; illustrative materials of all kinds, including slides and films; new experiments.

9. To present directly and in some detail tried methods of teaching some of the more difficult phases of chemistry; such as valence, atomic structure, the electron theory, etc.

10. To give direct information as to best practices, costs, methods of selection and purchase of supplies, and other similar topics relating to laboratory instruction and laboratory maintenance.

11. To give direct instruction in the technic and methods of experimental demonstration as applied to the teaching of chemistry.

12. To give direct advice and assistance to each student who wishes aid in the solution of his own teaching problems.

13. To give assistance to each student who needs it, in determining the work for which he is best fitted, his needs in the way of professional training, and how to find and hold the position for which he is fitted.

Content of a Course in "The Teaching of High-School Chemistry"

I. History of Secondary Education in the United States.
   A. The early Latin Grammar Schools, the Academy, the early High Schools.
      The nature of these schools, what they contributed to the modern school.

II. A Century of Chemistry in Secondary Education.
   A. Chemistry in Early High Schools.
   B. Chemistry in 1840.
   C. Chemistry in the Civil War period.
   D. Chemistry after 1872.
   E. Chemistry in 1900.

The nature of subject-matter used; educational theories and practices

of each period; remnants from these periods that are still with us and how they influence present-day teaching.

III. Chemistry in Present-Day High Schools.

A. Facts as to present status.

1. Number of high schools and high-school pupils.
2. Number of schools giving chemistry.
3. Number of pupils enrolled in chemistry.
4. Various types of chemistry courses.
5. Grade placement of chemistry.
6. The preparation of chemistry teachers.
   (Amount and kind of preparation.)
7. What chemistry teachers are actually required to do.
8. Amount invested in laboratory equipment.
9. Cost of chemistry per pupil per semester (supplies).
10. Teaching costs in chemistry (instruction).
11. Textbooks.
12. Chemistry as an elective or required subject.

B. Standardizing agencies.

1. College Entrance Examination Board.
2. The Board of Regents of New York State.
3. The North Central Association of Colleges and Secondary Schools.
4. State Departments of Education.
5. Universities.
6. The Committee on Education of the American Chemical Society, and the Senate of Chemical Education.
7. Courses in the Teaching of Chemistry in Universities and Colleges.
   (What they are; how they influence chemistry teaching.)

C. Present practices in chemistry teaching.

1. Plans and methods of teaching chemistry in the high school (very brief survey).
   (*a*) Class-recitation-textbook-laboratory plan.
   (*b*) Class-recitation-textbook-supervised-study plan.
   (*c*) The Contract plan.
   (*d*) The Unit plan.
2. The present status of laboratory instruction.
3. Present methods of testing.

D. Criticisms of present-day high-school chemistry (brief summary).

E. Definition of the major problems involved in the teaching of high-school chemistry.

1. Curricular problems.
2. Instructional problems.
3. Administrative problems.
4. Problems of equipment and maintenance.

Up to this point all efforts have been directed towards developing a foundation upon which to base a discussion or study of present-day problems involved in the teaching of high-school chemistry. It is obvious that no intelligent study or discussion could be made unless members of the course had a general understanding of present-day conditions, and of the past history of high-school science teaching as far as it influences present conditions.

IV. Methods of Educational Investigation.

A. The scientific method.

B. The scientific attitude.

C. Methods of study. Problem solving.

D. Earmarks of the good investigation.

E. A study of some typical investigations in chemistry teaching.

1. What was the problem?
2. What was the method?
3. What were the findings?
   (*a*) Was the method a good one?
   (*b*) Did it really find what it claimed? Were the findings valid?
   (*c*) Sources of error.
   (*d*) Usefulness and limitations of the method.

F. Application of typical methods of investigation to some of the major problems of chemical education. (Steps.)

1. Clearly define problem.
2. Limit it for clarity and accuracy.
3. Gather available data.
4. Evaluate and classify data.
5. State conclusions as generalizations.
6. Use those generalizations in solving individual problems.

The materials given under IV above are for the purpose of developing an appreciation of scientific investigations in the field of science education, and a confidence in their findings. This, of course, involves some study of the

methods used, a discussion of the earmarks of good and poor investigation, but it is not intended to develop technic in methods of investigation.

V. Determination of the Objectives of High-School Chemistry.

A. Symposium of opinions of experts. Limited value of opinions.

B. List of Dr. S. R. Powers of Teachers College.

C. Report of Committee on Education of the American Chemical Society.

D. Objectives in the light of:

1. Our changing ideals.
2. The changing needs of society.
3. The new knowledge of educational psychology.

E. Methods of determining objectives of Charters, Bobbitt, Hopkins, Harap, and others.

F. Curriculum making in Denver, St. Louis, Los Angeles, and other cities.

VI. The Selection and Organization of Subject-Matter.

A. What *actually* determines what we teach?

B. What *should* determine what we teach?

C. Principles of selection.

D. The three levels of subject-matter:

1. Minimum essentials.
2. Near essentials.
3. Local essentials.

E. Principles of organization.

1. Organize for teaching purposes.
2. Organize to facilitate supervision.
3. Organize to facilitate the use of a good text.
   (*a*) The organization of each unit.
   (*b*) How to determine sequence, stress, etc.

F. Typical courses of study.

1. American Chemical Society.
2. Unitary course.
3. Courses as indicated by the better texts.
4. Courses of certain cities and states.

G. Choosing a text.

1. Rating texts as to general worth.
2. Rating texts to fit particular needs.

H. The determination of the amount and nature of the laboratory work to be offered—its relation to subject-matter.

I. The coördination of high-school and college chemistry.

1. The work of the Committee on Education of the American Chemical Society.
2. The Senate of Chemical Education.

VII. Methods of Teaching Chemistry.

A. Distinction between *methods* and *plans* of teaching.

B. Evaluation of methods in common use.

Individual instruction, the lecture, textbook-recitation, question and answer, class demonstration, project method, laboratory method, problem method, supervised study.

C. Laboratory teaching.

1. Objectives.
2. Selection of experiments, problems, and projects.
3. Quantitative laboratory determinations.
4. Coördination of laboratory and classroom instruction.
5. Notebooks.
6. Control technic.

D. Methods, plans, and devices for teaching the more difficult phases of chemistry. (A study of the methods of the best teachers—brief.)

1. The beginning inspirational lecture.
2. Producing the desired attitudes in beginning classes.
3. The nature and composition of matter.
4. Chemical and physical change.
5. Elements, compounds, mixtures, atoms, and molecules.
6. The gas laws.
7. Chemical equivalents and valence.
8. Equations.
9. Solutions.
10. Chemical equilibrium.
11. Acids, bases, and salts.
12. The ionic theory.
13. Atomic structures.

VIII. Teaching Plans—College Level. (Briefly discussed if the class is interested.)

A. Time-classroom-laboratory.

B. Texts.

C. Classroom instruction.

D. Laboratory instruction.

E. Special features.

F. Beginning instruction.

G. Remedial instruction.

IX. Teaching Plans—High-School Level.

A. The textbook-recitation plan.

B. The textbook-recitation-supervised study plan.

C. The job or contract plan.

D. The unit plan.

(The advantages and disadvantages of each plan, and the function of the teacher at various stages.)

X. The Measurement of Results.

A. Objectives of testing.

B. Kinds of tests and how they are used.

C. Tests of particular value in teaching chemistry.

D. Results with the various standardized tests.

XI. Special Aids, Methods, Means, Ways, and Devices for Enriching the Course in Chemistry.

A. The Library.

B. Easily available illustrative materials.

C. Essential tools. (Experiments giving first-hand contacts.)

D. Special experiments.

E. The chemistry club.

F. Scrap book, files, and bulletin board.

G. Collections.

H. Projection apparatus.

I. Field trips.

XII. The Laboratory.

A. Expert planning and buying.

B. The cost of essential equipment.

C. Minimum essentials in equipment. Specifications and essential information as to quality, materials, etc.

D. Specifications for essential apparatus and chemicals.

E. Laboratory costs. (Maintenance.)

The materials presented under VII, VIII, IX, X, XI, and XII are all intended to be of greatest possible use to the actual classroom teacher. Immediate values are given first consideration although deferred values are also kept in mind.

XIII. Professional Problems of the Chemistry Teacher.

A. What chemistry teachers actually are required to do. (Review.)

B. Preparation needed.

C. A suggested curriculum.

D. Getting and holding a position.

E. Keeping efficient.

1. Keeping up-to-date.
2. Keeping physically fit.
3. Keeping alive to the obligations of the profession.

The materials under XIII are given with the personal interests of the individual teachers in mind. Many teachers have personal problems which cause them to need advice and assistance that can only come from one with long experience and greater insight than that of the ordinary teacher.

SIXTH NATIONAL COLLOID SYMPOSIUM

The Sixth National Colloid Symposium of the Division of Colloid Chemistry of the American Chemical Society will be held in Toronto, Canada, June 14th, 15th, and 16th, with Sir William B. Hardy, of Cambridge, England, as the guest of honor. Present indications are that biology and cellulose will receive special emphasis. The preliminary program will be published in a later number.

Ground Glass Proposed as Novel Blackboard. Blackboards of translucent ground glass lighted from behind are proposed as a substitute for the opaque black surface familiar to every school child. Prof. W. Weniger, of Oregon Agricultural College, has demonstrated this new blackboard and is using it in teaching his physics classes.

The old type of blackboard is difficult to illuminate so that all the room can see, Prof. Weniger found, while the ground glass electrically lighted from the rear allows everything chalked upon it to be seen from all parts of the room even when a combination of daylight and artificial illumination is being used. Erasing on the new "blackboard" is easy. It can also be used as a stereopticon screen and chalk talks can be interspersed with lantern slides without changing the lighting of the room.—*Science Service*

THE RESEARCH INSTRUCTOR FOR COLLEGES

HARRY N. HOLMES, OBERLIN COLLEGE, OBERLIN, OHIO

In every college faculty (I am not referring to graduate universities) are men trained to research who are no longer productive. In most instances the instructor is not to blame. Heavy routine teaching duties use up all his time and energy. Yet many of these men could do excellent research if properly encouraged and the scientific world would gain.

Better yet, the undergraduates would gain, from the authority, the freshness that contact with research gives to instruction. Live men, eager to produce, are often turned away from the college to the graduate faculty or to industry where they are encouraged to exercise their precious gift of originality. But why should a short-sighted policy deprive more than 700,000 undergraduates in the United States of teachers using the research attitude of mind in their routine courses?

Without a staff of productive men, how shall the college meet the challenge of the gifted student? Informational teaching is not adequate, but sound instruction in the research method of approach to all problems will stimulate the gifted student to do his best. Even a freshman will ignite from the right sort of spark, although he will not actually engage in research.

To attract research men to our college faculties they must be given sufficient free time, a proper library, special equipment, and, if possible, research assistants.

An important educational experiment worth watching in this connection is being tried at Oberlin College. Partly to provide the writer of this paper with highly skilled aid in his colloid-chemical research, partly to honor Charles M. Hall of aluminum fame, and partly to train men for college faculties a "Charles M. Hall Research Instructorship in Chemistry" was established.

A young man who has but recently taken his Ph.D. degree and who has some interest but little or no experience in teaching is appointed Research Instructor for one year only at $2000.00. Three-fourths of his time is spent in coöperative research on colloid problems with the writer of this paper. For the remainder of his time the young man serves as a teaching apprentice to the entire staff. Thus he learns whether or not he likes the teaching field or is qualified for it. He gets a training in colloid chemistry and his name may appear on a published paper. Furthermore, he has such teaching prestige as the title of Instructor gives.

It is hoped that other colleges will try this method of doing two or three good things at one stroke. Thus research men will be attracted to, or held on their faculties and the teaching profession will gain more good recruits.

POSITIONS OPEN TO GRADUATE STUDENTS MAJORING IN CHEMISTRY, IN VARIOUS COLLEGES AND UNIVERSITIES

COMPILED BY WM. MCPHERSON, THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO

Below are listed various Fellowships, Scholarships, and Part-Time Assistantships open to graduate students majoring in chemistry in different colleges and universities for the academic year 1928–29. It is possible here only to give a very brief statement concerning these positions. Further details as well as application blanks may be obtained from the persons designated or in case no one is mentioned, by writing directly to the Departments of Chemistry in the colleges and universities listed. In general, it may be stated that candidates for these positions must file their applications as soon as possible. The colleges and universities are listed in alphabetical order.

Brown University, Providence, R. I.—2 Metcalf Fellowships ($1000); 1 du Pont Fellowship ($750); 1 Rice Fellowship ($700); 3 University Fellowships ($750); 10 University Scholarships (stipend covering tuition); 3 Graduate Assistantships ($600 plus tuition). Holders of fellowships are required to pay tuition ($300) except that on recommendation of the department the tuition will be remitted to fellows reporting for research work on August 1st. Address inquiries to Charles A. Kraus.

California Institute of Technology, Pasadena, Calif.—4 Graduate Assistantships ($750); 6 Teaching Fellowships ($900); 1 Fellowship ($750); 2 Petroleum Fellowships ($1000 and $1200). The tuition ($180) must be paid until the holder has been accepted as a candidate for the Ph.D. degree, then half tuition ($90) is paid.

Catholic University of America, Washington, D. C.—6 Part-Time Assistantships ($180). Several Knights of Columbus Scholarships covering board and tuition.

Clark University, Worcester, Mass.—2 or 3 Graduate Laboratory Assistantships requiring 3 to 9 hours' work per week. Remuneration, $100 to $300 according to time employed. Address inquiries to B. S. Merigold.

Columbia University, New York City.—1 Special Research Assistantship ($1800); 2 Fritzsche Fellowships ($1500) (these two, at the option of Professor M. T. Bogert, may be combined into 1 with a stipend of $3000); various University Fellowships, Scholarships, and Assistantships available, varying from $500 to $1500.

Cornell University, Ithaca, N. Y.—3 Fellowships (from $400 to $750); 1 Scholarship ($200); 46 Assistantships ($500 to $675). Holders of all these positions are relieved from the payment of tuition and laboratory fees.

Duke University, Durham, N. C.—3 Graduate Assistantships ($600); 3 Fellowships (from $600 to $800). Address inquiries to P. M. Gross.

George Washington University, Washington, D. C.—4 Fellowships ($600 and free tuition). Address inquiries to Colin M. Mackall.

Harvard University, Cambridge, Mass.—Several Fellowships (from $300 to $750); 14 Laboratory Teaching Assistantships ($800). Inquiries should be directed to Professor E. P. Kohler.

Indiana University, Bloomington, Ind.—Special Fellowship ($1000 to $1200), minimum requirement, Ph.D. degree or equivalent; 1 Fellowship ($600); several Part-Time Assistantships ($400 to $800); Grasselli Chemical Company Fellowship ($350).

Iowa State College, Ames, Ia.—4 Scholarships ($270); 2 Fellowships ($540); 10 Graduate Assistantships ($800); 1 Industrial Fellowship ($900); 2 Instructorships ($1500).

Johns Hopkins University, Baltimore, Md.—The Grafflin Scholarship is awarded to a person with the Ph.D. degree or equivalent training and offers opportunity for independent research without distractions. It may be held for one or two years. The compensation is $1000.00 per year with remission of fees. Letter of application with recommendations should be addressed the Department of Chemistry before April 1st.

Kansas State Agricultural College, Manhattan, Kan.—No positions open to graduate students but the following positions are vacant: 1 Associate Professorship in Industrial Engineering Chemistry ($3500); 1 Assistant Professorship in Organic Chemistry ($2000). Address inquiries to Professor H. H. King.

Lafayette College, Easton, Pa.—2 Fellowships ($750). Address inquiries to Eugene C. Bingham.

Massachusetts Institute of Technology, Cambridge, Mass.—Several Part-Time Assistantships, usually appointed from resident graduate students.

New York University, University Heights, New York City.—First-year Fellowships ($600), exemption from fees in three courses, average cost of fourth course, $76; 6 to 8 hours per week teaching required. Advanced Fellowships ($800), exemptions, fees, and duties as above. Address inquiries to Arthur E. Hill.

Northwestern University, Evanston, Ill.—Several Graduate Assistantships ($650 to $800); several Research Fellowships ($500 to $1000); several University Fellowships ($500).

Oberlin College, Oberlin, Ohio.—Charles M. Hall Research Instructorship ($2000), Ph.D. degree prerequisite, three-fourths time to be spent in joint colloid research with Prof. H. N. Holmes, one-fourth as "teaching apprentice." Grasselli Fellowship ($500, free tuition and fees). 1 Graduate Assistantship ($750, free tuition and fees), 15 weekly clock hours of teaching in Freshman laboratory required. 2 Graduate Scholarships (free tuition, equivalent to $300).

The Ohio State University, Columbus, Ohio.—13 Part-Time Assistantships ($1000); 30 Graduate Assistantships ($500); 1 Special Fellowship ($750); a number of University Scholarships ($300) and University Fellowships ($500) are also open to students in chemistry. All of the above carry exemption from fees (except matriculation fee of $10) and cost of chemicals.

The Pennsylvania State College, State College, Pa.—Several Graduate Assistantships ($800); several Scholarships (no stipend but exemption from fees).

Princeton University, Princeton, N. J.—A number of Part-Time Assistantships ($650 and free tuition).

Rice Institute, Houston, Tex.—A number of Teaching Fellowships ($500 to $750 with exemption from fees).

Stanford University, Stanford University, Calif.—A number of Fellowships ($750); several Graduate Scholarships ($200); several Teaching Fellowships ($600).

State University of Iowa, Iowa City, Ia.—5 Scholarships ($200); 4 Fellowships ($400 to $1000); 3 Research Assistantships ($350 to $800); 1 Research Associate ($1000 plus); 18 Graduate Assistantships ($350); 15 Graduate Assistantships ($700 to $800). Address inquiries to Professor Edward Bartow.

Syracuse University, Syracuse, N. Y.—10 University Fellowships ($500). These are open to students in all departments. 16 University Scholarships, available to students in all departments (free tuition and laboratory fees); several Half-time Assistantships ($750 increasing, by two successive yearly installments, to $1000).

University of Akron, Akron, Ohio.—2 Fellowships in the study of Rubber Chemistry ($1000 and exemption from all fees). Address inquiries to Professor H. E. Simmons.

University of Arkansas, Fayetteville, Ark.—1 to 3 Half-Time Assistantships ($600); 1 to 3 Assistantships (fourth-time) ($250). Inquiries should be addressed to Professor Harrison Hale.

University of California, Berkeley, Calif.—20 Fellowships and Teaching Fellowships (these positions net about $650 after all fees are paid). Inquiries should be addressed to Professor G. N. Lewis.

University of Chicago, Chicago, Ill.—Swift Fellowship ($900); Lowenthal Fellowship ($450); Edith Barnard Fellowship ($200); 4 University Fellowships ($510); 5 University Service Scholarships (free tuition); 5 Assistantships ($810); 7 or 8 Assistantships ($410–$510); 1 Lecture Assistantship ($880); 1 Lecture Assistantship ($400). Holders of all the above positions are required to pay tuition fees except the University Service Scholars. Address inquiries to Professor Julius Stieglitz.

University of Cincinnati, Cincinnati, Ohio.—2 Fellowships ($500); 8 to

10 Graduate Assistantships ($600 to $750). Address inquiries to Professor H. S. Fry.

University of Colorado, Boulder, Colo.—A number of Assistantships in analytical and general inorganic chemistry ($600); 1 half-time instructorship ($800).

University of Florida, Gainesville, Fla.—4 Fellowships ($500). Laboratory instruction not to exceed 12 hours per week required. Address inquiries to Dr. T. R. Leigh.

University of Illinois, Urbana, Ill.—Several Half-Time Assistantships ($600 the first year, $700 the second); several Quarter-Time Assistantships ($300 the first year, $350 the second); several Scholarships available to students in all departments ($300 the first year, $400 the second, $500 the third).

University of Kansas, Lawrence, Kan.—10 University Fellowships ($400); 11 Part-Time Graduate Assistantships ($400 to $1000). Inquiries concerning Assistantships should be addressed to Professor H. P. Cady.

University of Maryland, College Park, Md.—3 Teaching Fellowships ($500) requiring six hours actual teaching and 6–8 hours outside preparation; 3 Teaching Assistantships ($1000) requiring 12 hours actual teaching and 10–12 hours outside preparation; 2 Teaching Assistantships ($1500) requiring half-time; 1 Research Fellowship ($500); 4 Research Fellowships ($750); 3 Research Fellowships ($1000). These positions carry free tuition and exemption from fees.

University of Michigan, Ann Arbor, Mich.—16 Teaching Assistantships ($800); 1 or 2 University Fellowships ($200 to $400); Prescott Fellowship in organic chemistry ($300); du Pont Fellowship ($750).

University of Minnesota, Minneapolis, Minn.—25 Teaching Assistantships for graduates ($650, first year; $750 after first year), 12 hours per week laboratory instruction required. 2 Full-time Fellowships without instructional duties; Shelvin Fellowship ($500); du Pont Fellowship ($750). Address inquiries to S. C. Lind.

University of Missouri, Columbia, Mo.—10 to 12 Graduate Assistantships ($600 to $700 depending upon experience); 8 to 10 Student Assistantships ($120); 1 University Fellowship ($600); 1 or 2 University Scholarships ($300). Address inquiries to Professor Herman Schlundt.

University of Nebraska, Lincoln, Nebr.—Several Scholarships and Fellowships ($500 to $750).

University of North Carolina, Chapel Hill, N. C.—3 Teaching Fellowships ($500); 1 Ledoux Fellowship ($300); 8 Assistantships ($500).

University of Pennsylvania, Philadelphia, Pa.—Scholarships (free tuition); Fellowships ($200 to $1500). Address inquiries to Owen L. Shinn.

University of Pittsburgh, Pittsburgh, Pa.—8 Graduate Assistantships ($800 for 10 months, free tuition, and remission of fees). Prerequisites

are B.S. or M.S. in chemistry or chemical engineering; 12 to 15 hours' laboratory instruction per week required. Student may carry 9 credits per semester.

University of Texas, Austin, Tex.—A total of 26 tutors and assistants are employed by the department of chemistry. Total service required, 22 hours a week. Base salary, for assistants, $500; for tutors, $725 per annum. Address inquiries to Professor H. L. Lochte.

University of Virginia, University, Va.—7 Teaching Fellowships ($500 and exemption from tuition and fees); 1 Fellowship ($750). Several University Fellowships.

University of Washington, Seattle, Wash.—3 Teaching Fellowships ($720). Address inquiries to H. K. Benson.

University of West Virginia, Morgantown, W. Va.—3 to 6 Graduate Assistantships ($650), 16 clock hours' work required. 2 to 4 Graduate Assistantships ($500), 12 clock hours' work required. Address inquiries to Friend L. Clark.

University of Wisconsin, Madison, Wis.—1 duPont Fellowship ($750); 2 University Fellowships ($600); several Scholarships ($250); 15 Junior Assistantships ($600); 6 Senior Assistantships ($1000). Address inquiries to Professor J. H. Mathews.

Vanderbilt University, Nashville, Tenn.—10 Scholarships ($100); several Fellowships ($300). These positions carry exemption from tuition and fees.

Washington University, St. Louis, Mo.—6 Assistantships ($750) with free tuition, laboratory fees, and allowance for breakage. Assistants are required to give about twelve hours a week to laboratory teaching. In addition the University appropriates funds for fellowships ($500) and scholarships ($200) with free tuition, etc., and no teaching duties. Address inquiries to L. McMaster.

Western Reserve University, Cleveland, Ohio.—3 Fellowships ($900 and tuition); several Assistantships, compensation depending upon amount of service. Address inquiries to Office of Graduate School.

Yale University, New Haven, Conn.—A limited number of laboratory Assistantships ($750). These positions do not carry exemption from fees. 1 Loomis Fellowship ($1500); several Scholarships and Fellowships, usually not awarded to men applying from outside the department.

It is certain that a serious attention to the sciences and liberal arts softens and humanizes the temper, and cherishes those fine emotions in which true virtue and honor consist. It rarely, very rarely happens that a man of taste and learning is not, at least, an honest man, whatever frailties may attend him.—DAVID HUME

SANITATION, SAFETY, AND CONVENIENCE IN PIPETTING*

ROBERT F. MCCRACKAN AND EMANUEL PASSAMANECK, MEDICAL COLLEGE OF VIRGINIA, RICHMOND, VIRGINIA

Unsanitary practices connected with the use of pipets are common in many laboratories. Pipets often show in their upper ends a deposit of solid material from dried saliva. It is common for two or more people to put their mouths on the same pipet without rinsing it, and rinsing it fails often to get it clean. Many people put unclean fingers on the upper ends of pipets and then put their mouths where their fingers were. We show here some devices being tried in our laboratory to make the pipetting of solutions sanitary and at the same time convenient and safe.

Figure 1 shows a device for filling a pipet by means of a siphon. The rubber tip *b* is attached to the bottom of the pipet, and the pipet, in an upright position, is then lowered till the graduation mark is a little below the level of the top of the solution in the bottle. The flow is controlled by pressure between the thumb and forefinger on the siphon *a*, and no pinch-cock is necessary. Incidentally, this siphon can be used in the same way to fill burets, and it can also be used without the rubber tip to fill burets from the top. There are no restrictions on its use for scientific purposes and anybody can make it. A simple and less breakable form for general laboratory use is that in which the tube within the bottle is rubber connected to a glass tube leading through the stopper, and where the glass elbow in the end of the siphon fits into the hole in the stopper directly instead of into a glass tube. A very convenient variation of this, where large classes are to use it, is to have a four-holed rubber stopper, three holes of which receive glass elbows at the ends of three branches of the siphon, the branching being effected by means of glass or brass Y-tubes. Thoughtless students cannot raise the loop higher than the level of the liquid if the siphon is passed beneath a shelf or table supporting the bottle before it is set in operation and hooked up. These siphons work well with water, and with many dilute aqueous solutions, but they cannot be used with anything that acts on the rubber.

Figure 2 shows a device for filling a pipet by pressure. The air pressure is increased by means of the bulb *b*, best worked with the left hand while the pipet is held in place by means of the thumb and middle finger of the right hand. When the solution goes a little above the mark the index finger is placed on the top of the pipet, and the stopper *a* removed enough to bring the tip of the pipet into the neck of the bottle. The solution is then drawn down to the mark, and the drop touched off. It works satisfactorily where large experimental errors are allowable. When great ac-

* Read before the Division of Chemical Education of the American Chemical Society, Richmond, Virginia, April 13, 1927.

curacy is required some objections to it are: that a large part of the outside of the pipet is wet by the liquid, thus causing too much to be delivered; that the pipet often fails to reach the last few hundred cc. of solution in the bottle; that objectionable fumes in excessive amounts may enter the bottle with so much pumping; and that the pumping may cause too much evaporation in the case of standard solutions.

Figure 3 shows a device by means of which the first two objections to the apparatus shown in Figure 2 are overcome. By placing the left thumb

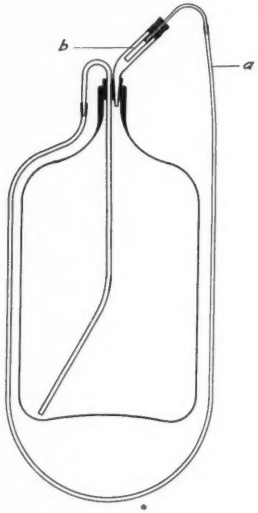


Fig. 1

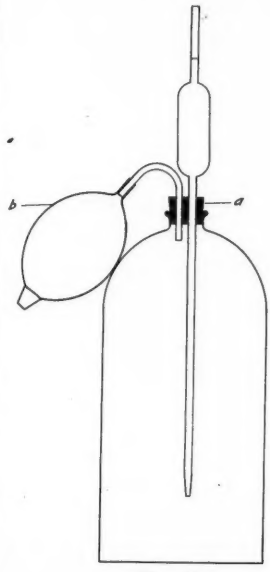


Fig. 2

and left forefinger over the holes *c*, and exerting pressure on the rubber bulb with the left hand all the solution in the bottle can be made to pass up tube *a*, and if a pipet or a buret be fastened in this tube by means of an air-tight stopper when the tube is large, or by means of a piece of very elastic tubing when the tube is small (Fig. 4) the solution will ascend the pipet or buret without wetting more than a centimeter of the outside of the tip. The pipet is held with the right hand, and the pressure is automatically released when the left hand is removed. The solution in the pipet should be forced a few centimeters above the mark, and should not be drawn down until after the stopper is loosened. If it becomes neces-

sary to force more solution into a partly filled pipet after air is admitted to tube *a* it is well to first drain the pipet completely or to force the solution up tube *a* and bring it in contact with the bottom of the pipet before tightening the stopper. When the apparatus is not in use it can be made nearly air-tight by placing a stopper in tube *a*, or a rubber cap (Fig. 4) on the end of the pipet. Then, by removing the glass tube to which the bulb is attached and inserting a plug the apparatus can be made completely air-tight.

All the mentioned objections to apparatus of the type shown in Figure 2

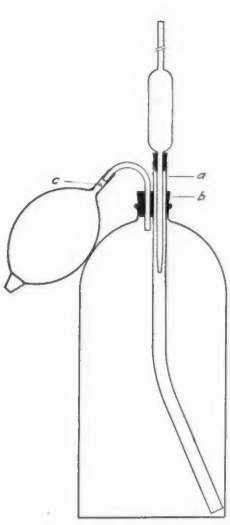


Fig. 3

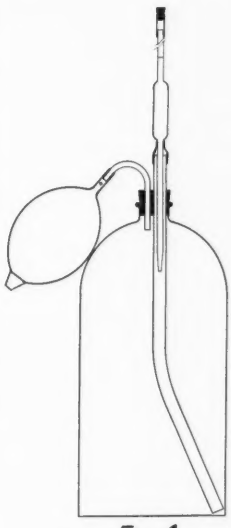


Fig. 4

may be overcome by applying suction to the pipet (Fig. 3). But in doing this we are liable to fall into old unsanitary practices. Most of the unsanitary evil in pipetting can be gotten rid of, however, by having individual mouthpieces. These are easier than pipets to keep in sanitary condition, and they can be used exactly as if they were the upper ends of the pipets. Figure 5*a* shows a very simple device for using an individual mouthpiece. The upper end of the pipet is pushed about half way through a long, fairly heavy rubber stopper, and the individual mouthpiece, a short straight tube, is pushed nearly half way through from the other end. If a curved mouthpiece (Fig. 5*b*) be used, the pipet can be suspended. The solution is drawn up by suction applied to the mouth-

piece, and the index finger is placed on the end of it instead of on the end of the pipet. Control is more perfect than with the pipet alone in that the warmth of the thumb and middle finger does not expand the air in the pipet when they grasp the stopper instead of the glass. The mouthpiece must fit moderately tightly or the stopper may pull loose, and one must be careful not to push the pipet out of the stopper while inserting the mouthpiece. Where a stopper is to be permanently in place on the pipet a very tight fit can be obtained by heating the upper end of the pipet so it will burn the rubber a little as it is inserted.

Figure 6 shows another device by means of which an individual mouth-

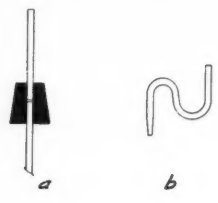


Fig. 5

Fig. 7

Fig. 6

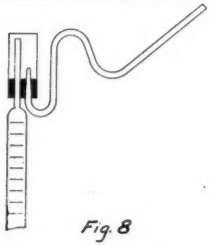


Fig. 8

piece can be used. Here the pipet and the mouthpiece pass through a two-holed rubber stopper into a closed space made by slipping a buret cap or a small test tube or bottle on the stopper. These devices greatly reduce unsanitary practices, but they do not do away with the necessity of putting the mouth where the finger has been. This objection is overcome by the device shown in Figures 7, 8, and 9, where the individual mouthpiece is used, and the space about the top of the pipet can be opened or closed off by means of a stopper or a portion of the hand or finger. When the pipet is filled the index finger is slipped quickly in place. The device shown in Figure 9, which can be slightly improved by beveling the top of the pipet a little, is made wholly of glass except the rubber tube, *a*, for the insertion of the individual mouthpiece. It was obtained for us

by Phipps and Bird, Inc., Richmond, Va. If patent rights can be obtained the Empire Laboratory Supply Co., Inc., of New York City will carry it in stock. By cutting the pipet a few centimeters below the cup one can get a sanitary attachment that can be used with any number of pipets, connection by means of a short piece of heavy rubber tubing only being necessary. The basic idea involved here was covered by Sharples' U. S. Patent number 553,004, granted 1896 and now expired, but this was an overflow type with the bulb of the pipet wholly surrounded by a jacket that Sharples called the overflow chamber, and he seems not to have associated the idea with sanitation in connection with the use of

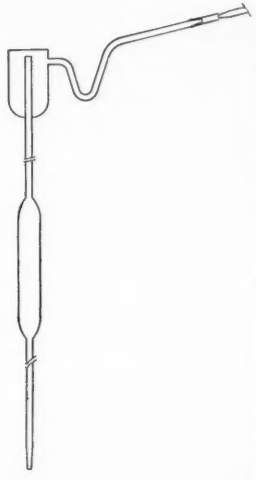


Fig. 9

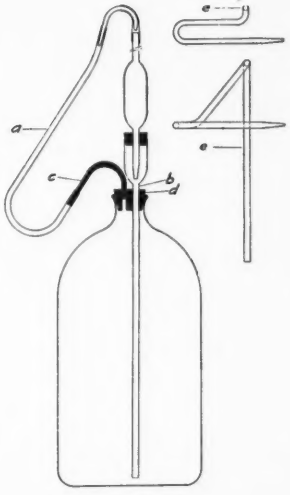


Fig. 10

ordinary laboratory pipets. The smaller the hole in the lower end of the pipet, and the lower the graduation mark on the neck, the easier it is to get the finger in place in time to control the flow, but when the hole is very small too much time is used in filling the pipet and also in allowing it to empty. It is not difficult to attain a happy medium. It is then possible sometimes with practice to dispense with the jacket about the top of the pipet, and to connect the mouthpiece with the pipet directly by means of a short or long piece of very flexible rubber tubing. With a little practice one can slip the rubber off and get the index finger in place in time to control the flow.

Figure 10 shows the arrangement of apparatus for pipetting very large or very small amounts of dangerous solutions, such as Nessler's solution,

for example, from the bottoms of very large bottles. The extension tube *b* can be kept permanently in the bottle with a solid stopper in it. A pipet of any size with a rubber stopper on it is placed in the mouth of *b*, a U-shaped piece of glass tubing much constricted at both ends is pushed into a very flexible piece of rubber tubing *a*, and the latter attached to the end of the pipet. This glass tube prevents kinking, and in case the liquid accidentally spurts up the pipet it slows its passage through the tube leading to the mouth. The mouthpiece of any shape goes in the other end of the flexible rubber tube. If it is constricted slightly it is the more easily inserted, and if it is curved like an S with its loops in planes at right angles (Fig. 10*e*) it can be hung on the neck of tube *b* when not in use. The rubber tube can be left attached to it, and the other end of the rubber can be hung in the other loop of the S. Figure 10*c* shows a plug for the air inlet through stopper *d*. When solution is to be pipetted, the plug is removed, and if made in the shape of a shepherd's crook it may be hung about the neck of tube *b*. When there is probability of the pipet being used again in a few days in the same bottle, the plug and pipet may be put in place and one end of the flexible tube *a* slipped on the pipet and the other on the end of the plug, making the bottle air-tight. A buret may be filled from the bottle in Figure 3 or Figure 10 by suction by passing the tip through a rubber stopper in the tube in the bottle and exhausting the air through a rubber stopper in the top of the buret.

We have found apparatus shown in Figures 1, 3, 5*a*, and 9 most satisfactory in our class work.

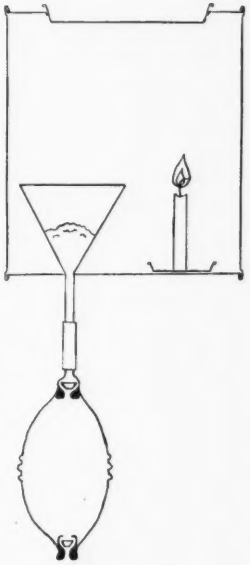
For making the apparatus shown in Figure 3, a nine-pound sulfuric acid bottle, a solid No. 5 rubber stopper, bored by ourselves, a No. 00 one-holed rubber stopper, and 14 mm. glass tubing of 12 mm. bore were used. The holes, *c*, were made with a paper punch. A nearly pure gum rubber tubing with a wall about 1 mm. thick was used for connecting pipets and mouthpieces. The troublesome coat of sulfur on rubber tubing and stoppers was removed by rubbing them with a wet file and rinsing with water.

Melon Ripening Hastened by Ethylene Gas Treatment. Casaba and honey-dew melons have been added to the list of fruits which can be given the color and texture of ripeness by treatment with ethylene gas, as a result of researches carried on by Dr. J. T. Rosa at the University Farm at Davis, Calif. Partly ripe melons, with rinds still green and flesh still hard, were subjected to the gas at a concentration of one part in 4000. They assumed the orthodox "ripe" color, and their flesh became soft. The sugar content, however, was not raised by the treatment. For this reason the hastening gas treatment is not recommended for fruits picked before a fairly advanced stage of maturity.—*Science Service*

A NEW METHOD FOR DEMONSTRATING DUST EXPLOSIONS

RALPH E. DUNBAR, DAKOTA WESLEYAN UNIVERSITY, MITCHELL, SOUTH DAKOTA

The author has used many of the traditional experiments, usually included in numerous texts and laboratory manuals, for the demonstration of the phenomena of rapid burning, oxidation and combustion, including dust explosions and spontaneous combustion. Among those frequently suggested is the use of yellow phosphorus dissolved in carbon disulfide. Also many combustible substances, such as wood charcoal, when heated to incandescence and poured into an open cylinder containing oxygen, burst into flame with almost explosive violence. These demonstrations undoubtedly have their advantages but in many cases the conditions under which the experiment is performed are more or less artificial. It has been the author's experience, through a period of years, that students frequently place the emphasis upon some incidental property of the chemical used rather than the central idea of the demonstration, unless their attention is specifically called to this fact.



The piece of simple apparatus, illustrated here, employs no superficial conditions or substances. A tin can of one-half to one gallon capacity with removable cover is selected. A small opening is made in the bottom through which the stem of a small laboratory funnel may be dropped. A rubber bulb, with valves for pressure, is connected to the lower end of the funnel by means of a rubber connection in such a manner that air can be forced through the funnel when desired. A small candle is then fastened to a suitable support so that it can be placed in the can or removed at will.

When the demonstration is to be performed, the funnel and bulb are arranged. A small amount of corn starch is placed in the funnel and the candle is lighted and lowered into place by means of suitable tongs. The cover is quickly placed in position and pressed down firmly. One or two puffs of air from the bulb through the funnel is usually sufficient to fill the can with cornstarch which causes an energetic explosion that throws the cover several feet into the air, but otherwise does not affect the apparatus.

It will be noticed that the conditions here are identical with those frequently encountered in practical experience, ordinary air, an open flame,

and some finely divided combustible material. The use of cornstarch closely resembles conditions found in starch factories. Finely divided coal, flour, and other similar substances may be substituted for the cornstarch, thereby giving a wide range of similar possibilities.

THE PREPARATION OF A WOOD CHAR

WILLIAM LLOYD EVANS AND JESSE E. DAY, THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO

The selection of a char, activated or otherwise, to be used in the quantitative synthesis of carbon dioxide as described by some of us[1] in a previous article has been attended with difficulties in this laboratory. We have since learned by eperiment that about 0.5 g. of wood char suitable for this experiment can be made by placing about 20 safety matches (with the heads removed) on a wire gauze and carefully heating them until a smoke is no longer observed. This product is forthwith placed in a weighing tube for immediate use in the carbon dioxide exercises.

[1] Evans, *et al.*, THIS JOURNAL, **2**, 932–5 (Oct., 1925).

Cotton Growing Must Stop in Southeast, Says Chemist. King Cotton must abdicate in what was once considered to be the very heart of his realm, the southeastern states. From central Mississippi eastward, it costs so much to grow cotton that the high-priced product cannot compete with the low-priced cellulose now being manufactured from wood and soon to be made from cornstalks. This thesis was boldly laid down before the annual meeting of the leaders of the naval stores interests, by Dr. William J. Hale, director of organic chemical research of the Dow Chemical Company, Midland, Mich.

"The old practice of raising cotton in this section seems destined to obsolescence," said Dr. Hale. "The cost of growing cotton in this section is approximately ten cents per pound and yet you must face the inroads of alpha cellulose from woody fiber offered on the market at eight cents. Millions of pounds of cotton will be displaced from industrial use this year in the manufacture of rayon and nitrating paper. Even cotton linters at four cents per pound cannot compete long, but possibly at two cents may still find considerable use. In other words, cotton must be driven to ten or twelve cents per pound if it is to hold its position in the textile world."

Cotton will still hold its own west of the Mississippi, where it can be produced at five or six cents per pound, the speaker stated. In the Southeast, its cultivation can be continued at a profit for some years to come on the larger plantations, but the smaller farmer will do well to look about at once for other crops. Dr. Hale recommended, especially, peanuts, which can be pressed for a high-grade food oil. Their shells also have good potentialities as industrial material. Sugar cane, where it can be grown, and sorghum to the north of the sugar cane belt were other suggestions. Besides their yield of sugar and molasses, these plants are coming into an immense demand as sources of fiber for artificial lumber.—*Science Service*

THE ST. LOUIS MEETING

The following notes are necessarily incomplete since they were written February 25th; final details of the program will appear in the April 10th issue of the *News Edition* of *Industrial and Engineering Chemistry.*

Registration will start at 10 o'clock Monday morning April 16th, Hotel Chase, and will continue throughout the convention. "The registration fee, required by vote of the Council of the A. C. S. to help carry local expenses, has been fixed at $3.00 for members and guests and at $5.00 for American non-member chemists."

Those desiring hotel accommodations should communicate with Eugene S. Weil, 316 S. Commercial St., while student reservations, at a nominal figure, may be secured by addressing the Local Secretary of the Division of Chemical Education, L. J. Wood, 1402 S. Grand.

Divisional meetings for the reading and discussion of papers will begin Tuesday morning and will continue until Thursday morning, starting each morning at 9.30 and each afternoon at 2.00. Thirteen of the nineteen divisions of the Society will hold from one to four half-day sessions each, detailed announcement of which will appear in the April 10th *News Edition* of *Industrial and Engineering Chemistry.*

Program of the Division of Chemical Education. Ballroom, Forest Park Hotel

Note—The several features of the general program which have been incorporated are so indicated.

Monday, April 16th

8.00 A.M.	Breakfast meeting of the Executive Committee, Hotel Chase
10.00 A.M.	Meeting of the Senate, Hotel Chase
12.15 P.M.	Luncheon, Senate and Division, Hotel Chase ($1.00)
5.00 P.M.	Meeting of Committee of Chemical Education, Hotel Chase
9.30 P.M.	Entertainment (whole Society)

Tuesday, April 17th

9.30 A.M.	Divisional Meeting—General Papers
12.15 P.M.	Luncheon, Forest Park Hotel ($1.00)

Note—Local high-school teachers of chemistry will be guests of the Division. The President of the A. C. S., the Chairman of the Division, and the Editor of the JOURNAL OF CHEMICAL EDUCATION will give informal addresses of welcome.

2.00 P.M. Symposium on The Teaching of Analytical Chemistry

(1) J. H. Reedy, University of Illinois, "Objectives and Content of the Introductory College Course in Qualitative Analysis"

Discussion led by G. W. Sears, University of Nevada

(2) H. H. Willard, University of Michigan, "Objectives and Content of the Introductory College Course in Quantitative Analysis"
Discussion led by H. V. Farr, Mallinckrodt Chemical Works
(3) C. W. Foulk, Ohio State University, "Advanced Work and Graduate Courses in Analytical Chemistry"
Discussion led by Stephen J. Popoff, University of Iowa

5.00 P.M. Meeting of Contributing and Departmental Editors of the JOURNAL OF CHEMICAL EDUCATION, Forest Park Hotel

6.00 P.M. Meeting continued at dinner, Forest Park Hotel

8.00 P.M. Public Meeting (whole Society)
Address by Wm. J. Mayo of the Mayo Foundation, Rochester, Minnesota. "The Advancement of Learning in Medicine through Biochemistry."

Wednesday, April 18th

9.30 A.M. Symposium on Analytical Chemistry (*continued*)
(4) Theodore D. Kelsey, Grover Cleveland High School, St. Louis, "The Teaching of Qualitative Analysis in Secondary Schools"
Discussion led by J. E. Wildish, Kansas City Junior College
(5) H. R. Smith, Lake View High School, Chicago, "The Teaching of Quanitative Analysis in Secondary Schools"
Discussion led by F. B. Wade, Shortridge High School, Indianapolis, Ind.
(6) N. H. Furman, Princeton University, "The Technic of Conducting the Introductory College Course in Qualitative Analysis"
Discussion led by L. J. Wood, St. Louis University
(7) E. G. Mahin, Notre Dame University, "Technic of Conducting the Introductory College Course in Quantitative Analysis"
Discussion led by J. Samuel Guy, Emory University

12.15 P.M. Luncheon, Forest Park Hotel ($1.00)

2.00 P.M. General Papers

3.30 P.M. Business Meeting, Senate and Division

The Swampscott Meeting

It is the earnest wish of the officers of the Division to represent the wishes of a majority of the members, and to arrange for each meeting the most acceptable program possible.

At the Detroit meeting of the Division last September, the feeling was expressed that the teaching of analytical chemistry and, particularly,

research in analytical chemistry are under-emphasized in America at the present time. The Secretary was instructed to arrange a Symposium on this general topic for the St. Louis Meeting.

Early in October the Senate of Chemical Education and the Contributing Editors of the JOURNAL were requested to suggest sub-topics and speakers for the proposed symposium. Acting upon the returns of this letter ballot, the secretary arranged the program as indicated above.

Plans for the Swampscott Meeting, in September, 1928, are already under way. To assist the Secretary in arranging the Divisional program, each member of the Division is urged to send suggestions on the form below.

Program Ballot—Division of Chemical Education

1. I suggest the following title for a Symposium at the Swampscott meeting.

   .....

2. I suggest that the following persons be invited to participate in this Symposium:

   .....

   .....

3. I expect to attend the St. Louis Meeting this April and to attend the Division luncheons (please check which ones) Monday, April 16th ( ), Tuesday, April 17th ( ), and Wednesday, April 18th ( ).
4. Remarks:

   .....

   .....

   .....

   .....

   ....

   (Date) (Signed)

PLEASE MAIL *AT ONCE* TO R. A. Baker, *Secretary*, Syracuse University, Syracuse, N. Y.

Self-Winding Clock Run by Thermometer. A self-winding clock, run by what is virtually a glycerin thermometer, has been invented by a Swiss engineer, Karl Heinrich Meier. It utilizes the energy captured by the daily fluctuations in temperature to raise the weights that drive its mechanism, and it is stated that one of the clocks has been kept going for a year on a daily range of not more than eight degrees Fahrenheit. The essential mechanism consists of a long coiled tube filled with glycerin, connected with a cylinder into which a piston is fitted. When the glycerin is warmed and expands, it forces out the piston, which in turn lifts the clock weight. It is expected that this device will be especially useful in operating outdoor clocks in public places. The types now in common use are usually electrically driven and are, therefore, expensive to install, besides requiring frequent attention.—*Science Service*

Hot Springs Minerals Laid Down Rapidly. The deposits of hot springs limestone, more properly known as "sinter," are laid down very rapidly, according to Margaret Lindsley, of the Yellowstone ranger staff, who has been making a study of the phenomena in the park for the geophysical laboratory of the Carnegie Institution of Washington.

She writes of one of her observations:

"A little wooden cylinder made expressly for measuring the rate of deposition was wired in place near the foot of Jupiter Terrace. This point is easily 300 feet from the hot spring at the top and only about 5 feet above the main highway. The water in tumbling down over the terrace is well aërated and cooled to a little above body temperature. The block and the wire which held it in place were removed 21 days later, covered with a deposit of chalk-like travertine to a thickness of from one-half to three-fourths of an inch. One might think that the water would lose most of its burden of mineral by the time it was at so great a distance from the point of emergence, but the experiment proves that such is not the case."—*Science Service*

German Factory Smoke Injures Field Crops. The Ruhr industrial region, recently restored to normal operation following the withdrawal of the French, has given a striking illustration of the damage wrought by factory smoke, not only to trees and gardens in the cities but to the farm crops throughout the countryside. When the French occupied the region in 1923 the Germans adopted a policy of "passive resistance," closing down all the factories. With the air cleared of its load of smoke and acid fumes, the farms of the Ruhr valley yielded full crops for the first time in many years. Then the French withdrew and the chimneys started smoking again, and now the crops have dropped back to their previous low level.—*Science Service*

Cadmium Metal Finds Use in Solders. Cadmium, chemical brother to zinc, is finding a useful place in industry as one of the components of special solders, Carl E. Swartz, metallurgist of Selby, Calif., told the American Institute of Mining and Metallurgical Engineers at New York recently.

Lead, tin, and zinc are the metals used in such common solders as those in sealing tin cans, but where lithographed labels are used on tin cans a special solder containing cadmium is now used because its lower melting point prevents discoloration of the lithographing.—*Science Service*

Watercress Has Many Vitamins. The list of foods the doctor says you should eat has been augmented by a new one, watercress.

This familiar garnish for meat and salad is a remarkably rich source of the vitamin necessary for growth and of the scurvy-preventing vitamin C, Dr. Katherine H. Coward and P. Eggleton, of the University of London, have found. It boasts of small quantities of vitamin D as well in its small green leaves.

The green shows considerable seasonal variation, however, in its growth-promoting properties, the investigators have found, being more effective with laboratory animals in this respect in spring and summer than in winter.—*Science Service*

CLASSROOM EMANATIONS

New elements: Materium and Absinium.

Three kinds of sulfur: Orthorhombic, Monoclinic, and Amphibious.

An electrolyte is a liquid which will allow the passage of an electric current and be somewhat disturbed by the passage.

The boiling point of a liquid is the point at which the temperature overcomes the specific gravity.

An acid anhydride is something which, when added to water, gives a base and when water is taken out of it, gives an acid.

To test the purity of a liquid, boil it in the presence of a thermometer.

Germs are so small that they can be seen only by a microbe.

A barometer is a Torricelli tube with complications.

Rainfall is thought to be a collection of dust around an electron.

"Beckerill," an important name in the chemistry of light, was given to the light waves or rays which a man by that name discovered and wondered about. When Mme. Curie, a young woman, was studying under him in Paris, he gave her these rays to work on to obtain her doctor's degree.

The length of a light wave is the distance from one chest to another.

An element is a substance which cannot be dissociated by the will of the experimenter.

Atoms are not attracted as are ions, but move in a blind sort of way.

To determine whether a compound is an ionogen an apparatus is set up. Wires are run through some of the compound and on to an indicator. If the indicator responds the compound is an ionogen.

The Greeks knew that a solid was rough and rigid in form and that it would stay where it was put.

The name given to the product of combustion is a *combuside.*

Water exists in two states, tap water and distilled water.

Anaxagoras, way back in the years before Christ, had some idea about matter.

The Modern Period of Chemistry was ushered in by a burning substance.

Michelson invented the *interthermometer* to measure the waves in a meter stick.

A saturated solution is a solution where the molecules are as great on the outside of the container as they are on the inside of the container.

The sensibility of a balance is the number of points the manufacturer's zero is off the true zero.

Sensibility is the weight which will move the balance one space to the right.

To form hydrogen peroxide, burn oxygen and hydrogen at a low temperature; add water and keep it dark.

Correspondence

THE PERCHLORATE METHOD FOR POTASSIUM—A CRITICISM

I would like to call your attention to some of the regrettable features of the article by J. P. Mehlig, in the December edition of the JOURNAL OF CHEMICAL EDUCATION, entitled "The Perchlorate Method for Potassium."

The paper, according to the author, "was undertaken with the idea in mind of showing the practicability of the perchlorate method as a suitable substitute, especially in the hands of students, for the chlorplatinate method."

The perchlorate has been previously shown to be not only a satisfactory method to substitute for the chloroplatinate method but is now recognized as a method superior in accuracy to the platinum process. In this connection, allow me to quote Professor H. H. Willard, Head of the Division of Analytical Chemistry in the University of Michigan in a book review of Mahin's "Quantitative Analysis," 1924 edition, to be found in the *J. Am. Chem. Soc.*, **49,** 2950 (1927) of which Professor Willard is associate editor. Referring to p. 84 of the Mahin text he says:

"On page 84, from a comparison between the perchlorate and chloroplatinate method for potassium, one would suppose that the former was less accurate and convenient whereas such is not the case. The statement made here and on p. 91 that the preparation of aqueous perchloric acid is dangerous is absurd. It is, however, quite unnecessary to prepare it because C.P. 60 per cent perchloric acid has been on the market for years and is no more dangerous than other common acids. The use of 20 per cent acid is a disadvantage and not an advantage."

The directly opposite position for all these points has been taken by Mehlig in the material of p. 1537. In addition the statement is made that: "Sodium perchlorate is easily soluble in alcohol but no definite data are available" is as with the rest of the material of this page not the result of very extensive search outside Mahin's text. Two references to such data are given by the following:

"The Perchlorates of the Alkali and Alkaline Earth Metals and Ammonium, Their Solubility in Water and Other Solvents." By H. H. Willard and G. Frederick Smith, *J. Am. Chem. Soc.*, **45,** 286 (1923).

"The Separation and Determination of the Alkali Metals Using Perchloric Acid. I. Solubilities of the Perchlorates of the Alkali Metals in Mixed Organic Solvents." By G. Frederick Smith, *J. Am. Chem. Soc.*, **47,** 762 (1925).

The practice of using perchloric acid—alcohol mixtures in this separa-

tion such as is advised by Mehlig on p. 1537 is neither necessary nor desirable. See G. Frederick Smith and J. F. Ross, *J. Am. Chem. Soc.*, **47**, 774 (1925). Also in this connection the temperature of drying potassium perchlorate should be 300–350°C. and not 130° as Mehlig recommends.

On p. 1540 in testing a method for the separation of potassium and sodium by analyzing 9 pure potassium salts is hardly a fair test of a separation from sodium. A little sodium salt could be added here easily and need not be accurately weighed. Note the following four analyses out of seven attempts by Mehlig:

Salt	Theory *K*	Amount found *K*	Error
KI	23.55	23.54 – 23.53	−0.01 and −0.02
K_2SO_4	44.88	44.88 – 44.84	±0.00 and −0.04
$KClO_3$	31.91	31.93 – 31.91	+0.02 and ±0.00
$K_2Cr_2O_7$	26.59	26.64 – 26.59	+0.05 and ±0.00

If these materials analyzed were pure and anhydrous, then as a result of the analyses obtained potassium perchlorate must be quantitatively insoluble in 97 per cent ethyl alcohol containing 0.2 per cent of perchloric acid. Such a series of results might be well obtained by analysis because there are several compensating errors following the directions as given in this paper by Mehlig. The writer is quite aware of these errors. Would not a careful observer wonder about the fact that, according to these analyses above given, potassium perchlorate is indicated to be insoluble?

As a result of the criticisms so far made I believe you can see clearly that the paper of Mehlig can hardly aid materially in causing the perchlorate method to be adopted more readily than it would if this had never appeared.

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G. FREDERICK SMITH,
Associate in Chemistry

IN REPLY

It is quite evident that Prof. Smith has misinterpreted the purpose of my paper on "The Perchlorate Method for Potassium," in his summary of the regrettable features as he chooses to call them. The work described in the paper was done to show the practicability of the perchlorate method as a suitable substitute for the chlorplatinate method, especially in the hands of students. It should be evident to every fair-minded observer that the paper proves exactly what it set out to do. No claim for any original research was put forward by the writer. The work was simply a tryout by students of the perchlorate method as given in standard texts of recent issue, such as Mahin's "Quantitative Analysis" and Scott's "Inorganic Quantitative Chemical Analysis."

The perchlorate method as used is not out of date as the dates of issue (1924 and 1926) of these texts show. Nor is the assumption by Smith that the method is widely known true. Many chemists and teachers are not familiar with it and it was the purpose of the writer to show to such that it is a satisfactory method. Griffin in his "Technical Methods of Analysis," 1925 edition, does not even mention the method.

The writer did not at any time take the position in opposition to Willard that the perchlorate method is less accurate and less convenient than is the chlorplatinate method, nor did he claim that the *preparation* of aqueous perchloric acid is dangerous. The statement made on p. 1537 is, "this solution (20% perchloric acid) keeps well and there is little or no danger of accident in handling it as there may be in handling the pure acid." Scott in his "Inorganic Quantitative Chemical Analysis," **1926,** p. 86, says, "Perchloric acid often explodes spontaneously. The pure acid explodes when heated to 92°." Sixty per cent perchloric acid might well be substituted for the 20%. This is immaterial.

It seems that the most grievous error that the writer made was in not referring to the work of Smith on the solubility of sodium perchlorate in alcohol and in not following the method as given by Smith in *J. Am. Chem. Soc.*, **47,** 762 (1925), and by Smith and Ross, *ibid.*, p. 774. The work was not a test of Smith's modifications, but simply a test to show the feasibility of the method as given in such standard texts as those of Mahin and Scott. The latter was published in 1926 *after* Smith's article was in print.

Even if Smith did find it necessary to dry potassium perchlorate at 300–350° to remove the last traces of moisture, the drying at 120–130° is sufficiently accurate for commercial analyses and gives satisfactory results.

The writer's results given on p. 1540 are not intended as a test of the separation of potassium from sodium. Certainly nothing is said in the article to give that impression. The test for the separation is shown in the results of the soil analyses on p. 1543. In this set of analyses very close agreement between the chlorplatinate and perchlorate results was obtained, sufficiently close to satisfy Prof. J. S. Jones, Chief Chemist of the Oregon State Experiment Station, that the method is a good substitute for the chlorplatinate method.

The citing of four analyses of pure potassium salts made by the writer, which Smith claims prove erroneously that potassium perchlorate is quantitatively insoluble in 97% alcohol, is obviously unfair. All the results or none should be considered. There are nine other analyses given in the article to say nothing of some twenty-seven student analyses that will ease the mind of the "careful observer" and cause him to cease his wonderings, if any.

OREGON STATE AGRICULTURAL COLLEGE,
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J. P. MEHLIG

Chemical Digest

ABSTRACTS

Factors Contributing to Success in College Teaching. FREDERICK S. BREED. *J. Educ. Res.*, **16,** 247–53 (Nov., 1927).—In a preceding paper the author has computed the average rank position from the judgments of 56 members of the faculty in the University of Chicago of each of 34 carefully selected instructional activities. In the present paper the same list of activities are ranked by 100 *students* in the same university. The two series of ranks are tabulated. Comparison shows there is little significant difference between the ranking by the faculty and that by the students.

The general impression that students place more stress on the personal qualities of their instructors than on any others is not substantiated. Students in this group do not accept neat appearance and general refinement of a teacher as substitutes for scholarship and instructional skill. Of the six cases of disagreement in ranking two are negligible and the other four are very suggestive. Students place higher value on making satisfactory assignments and on open-mindedness in the instructor, value less than he does his devotion to research, and are more concerned to have him manifest an interest in the general problems of the university.

The author concludes that students have something unique to contribute to our analysis of ability in college teaching, and that the opinions of both students and instructors should be used as sources of information in any attempt to define the job of the college instructor.

The list of qualities desirable in the college instructor included in this article is well worthy of the perusal of those who are working toward complete success in the classroom. R. M. P.

Failures among University Freshmen. GROVER H. ALDERMAN. *J. Educ. Res.*, **16,** 254–9 (Nov., 1927).—A study of the causes of failure of freshmen in the University of Pittsburgh was made by the author. This university is committed to the "open-door" policy of permitting any student who has completed the high-school requirements to enter. Seventy-one per cent of the students live in their own homes. There are many students whose parents were foreign born. Many students are partially or wholly self-supporting.

In 1923–24 the mortality had reached a maximum of 35 per cent. This was followed by a rapid decrease in mortality: in 1924–25 it was 19 per cent, in 1925–26 it was 18 per cent, and at the end of the first semester 1926–27 it was 9 per cent. Likewise the percentage of those who left the university because of low scholarship has decreased.

Three general factors have operated to give this decrease: improvement in teaching, careful counsel and guidance, and coöperation of parents. An educational clinic established by the chancellor was attended by the deans and heads of departments. Methods of classroom instruction and certain problem cases were discussed. Conferences on good teaching were held in almost every department.

Assistants to the Dean of Men and Dean of Women interview every freshman in the first four weeks. Scholarship checks are made at the end of each six weeks, each problem case being referred to the dean. The student may need sympathy, or encouragement, or he may be sent to the Department of Psychology or of Elementary Education. Several boys were found to fail because of sheer laziness.

A third factor in cutting down failures is the annual reception held for parents of freshmen for the purpose of reviewing work done by their sons and daughters and conferring with instructors. After a talk by the chancellor the six-weeks' marks are distributed to the parents. These reports carry the instructors' names, and each parent may confer immediately with the instructor of his child. In cases of failure these conferences often remedy the condition.

The author made a critical study of 89 freshmen who failed the first semester. It was found that many boys were failing because of over-crowded curricula in certain schools. The majority of those failing were *not* self-supporting, while 75 per cent came from well-to-do homes.

The Thorndike entrance examination test gave for these students the following

results: 1 received a grade between 90 and 100; 4 between 80 and 90; 8 between 70 and 80; 8 between 60 and 70; 13 between 50 and 60; and 33 below 50.

The name of no foreign-born student appeared on the list and only 16 failures were children of foreign-born parents while 73 came from American homes where they had every opportunity to succeed in life.

The author concludes that the average American student has sufficient mental ability to succeed in college work if he has the desire to do so, but when sent to school against his wishes his success is doubtful. R. M. P.

A Technic for Measuring the Efficiency of Supervision. L. J. BRUECKNER AND PRUDENCE CUTRIGHT. *J. Educ. Res.*, **16,** 323–31 (Dec., 1927).—There is little scientific evidence as to the value of work done by supervisors. Some are merely inspectors who do little constructive work; some demonstrate various methods of teaching and expect teachers to imitate their technics; others carry out carefully planned supervisory programs. The authors report an attempt to improve the efficiency and measure the effectiveness of certain supervision. The effectiveness is measured not by the results of standardized tests but by observed changes in class-room practice.

Information regarding current practices was obtained through a scheme which studied the different types of lessons in terms of objectives. Tabulated results of the survey are given followed by a discussion of the advantages gained in practice. It is suggested that the same methods may be used for measuring the teaching of other subjects. R. M. P.

The Value of Educational Research to the Classroom Teacher. CLIFFORD WOODY. *J. Educ. Res.*, **16,** 172–8 (Oct., 1927).—The author finds the possibility of the high or elementary school as a research institution is a relatively new conception, and points out the need of research in the immediate field of teaching. He finds at present that no scientifically established curriculum exists; one classroom organization is not known to be superior to another; the best method of evaluating instruction has not been determined; and no data has been gathered upon how the *child learns*—showing that in the science of teaching there has been little research.

The great body of data upon which our psychological laws and principles are based were developed in the laboratory and in the absence of actual teaching situations. As an example, the classic memory investigation of Ebbinghus was developed in the laboratory by having adults learn nonsense syllables. The key words in the previous sentence are "laboratory," "adult," and "nonsense." It is conceivable that different results might be obtained if for those three words "school-room," "children," and "sense materials" were substituted. The experience of an adult in sending and receiving telegraphic messages may or may not apply to the teaching of composition or of chemistry. Little evidence exists which shows to what extent this is true.

What is needed in research is a definite program directed by a capable agency, which deals with problems encountered by classroom teachers. The program should be organized somewhat after the fashion of the American classical investigation, or the report on social studies in the schools undertaken by the council of the American Historical Association.

Some values to be derived by teachers taking part in a research program are found in (1) the expert training, (2) superior teaching in the classroom, (3) stimulus to professional growth, (4) a mass of information provided with which to interpret current articles in educational periodicals, (5) an aid to establishing a teaching profession, (6) direct or indirect monetary rewards, and (7) a certain spiritual satisfaction.

R. M. P.

The Training of College Teachers. F. J. KELLY. *J. Educ. Res.*, **16,** 332–41 (Dec., 1927).—It is estimated that more than 75 per cent of those university graduates granted Ph.D. degrees go into teaching. The conviction that the graduate school does not give adequate teacher training is forced upon those interested in this phase of its work. Wilbur L. Cross, Dean of the Graduate School of Yale University, in an address pleaded for a new type of requirement for the Ph.D. degree determined by the broad training demanded of the undergraduate teacher as contrasted to the highly specialized training of the investigator.

Professor Richardson of Dartmouth states in regard to the situation in graduate schools: "We may conclude that no part of our educational system is in greater need of appraisement, of examination of purpose and method, or reorganization, in view of the needs of the times."

A resolution adopted in 1922 by the Land Grant College Association is worthy of note. Two clauses of this resolution stated: "That the Association of Land Grant Colleges declare this year in favor of professional training of college teachers," and "That be-

ginning with 1925 candidates for teaching positions in land grant colleges be required to have at least six semester hours of professional training, including courses in educational psychology and methods of teaching. As soon as possible this requirement should be increased."

A year ago in New York University new requirements for the Ph.D. degree were announced for prospective college teachers. The chief characteristics of the new requirements are that about one-third of the three years' graduate study is to be devoted to professional courses in education and in apprentice teaching, and that the thesis is to be on some phase of college, university, or professional education.

In answer to a questionnaire, thirty-six out of three hundred universities are reported to be making a serious effort to train teachers for college work.

The author defends three propositions which, in his judgment, would do most to forward the reorganization of graduate schools as training institutions for college teachers. First, a new curriculum dictated by a new objective must be put side by side with the present curriculum and both must lead to the same Ph.D. degree. . . To conclude that incorporating educational psychology and methods of teaching in the present curriculum of graduate schools will constitute a cure for inefficient teaching is to miss the main point. Where change is needed is in the essential spirit which dominates the graduate schools.

Second, the spirit of investigation into problems of college teaching must come to permeate the undergraduate college. This movement is on the way. There are essential principles which should operate to guide it. The investigations should be made with the active coöperation of college teachers in the various subjects. The responsibility for the investigations ought to lie with the academic teachers. A committee on research in college problems should be created in every institution. This committee could help to coördinate the various interests and bring to the problems which arise the sound technic of education.

Such a committee on educational research, consisting of deans and members of the faculty of the University of Minnesota, has been appointed. This committee is free to conduct investigations into any question concerning teaching or administration in the university. Among other activities a sub-committee on the teaching of science is at work, the main point of inquiry being whether the higher cost of laboratory method is justified in the case of the large numbers of elementary science students.

The general effect of the work of this committee on educational research has been to stimulate the spirit of experimentation on all manner of questions related to college teaching.

Third, courses in education should be built upon the results of experimentation recently conducted in the field of collegiate education. One of the things to be feared is that the departments of education when called upon to give professional training to prospective college teachers will make moderate revisions in their present courses and offer them as training for college teachers. The educational courses should not be "warmed-over" courses from the field of elementary and secondary education.

R. M. P.

The University as a Training School for College and University Teachers. V. T. THAYER. *J. Assoc. Am. Univ.*, Report **1926**, pp. 41–8.—Students can attend college four years without experiencing any fundamental transformation in their outlook on life. One explanation for this failure on the part of an instructor to touch vitally the students entrusted to him, lies in the absence of professional training for his duties. His crowning achievement has been the writing of a thesis. All of his training has been carefully directed away from teaching.

Many teachers . . . . . are determining influences in the lives of their students but *our universities are not at present organized with primary reference to giving birth to this type of instructor or encouraging his survival.* Instructors are not only untrained and ignorant of the character and needs of students; they find little in their own environment to stimulate an interest in teaching. The young instructor detects little concern on the part of his superiors that he develop as a teacher. He also discovers that it is not uncommon for his colleagues to look somewhat askance at those who devote their energies enthusiastically to teaching.

Teaching, to be successful, cannot go on without reference to the complex and varied interests and needs of the student body. In the American college it consists not only of those who wish to drink at ancient fountains of wisdom but also of those who seek only and are capable only of a practical application of knowledge.

To progressive educators subject-matter and method are inseparable if not identical. Intelligent teaching calls for a specialized knowledge of subject-matter. It calls for an

organization of subject-matter with special reference to the needs of the learner. . . . . A college instructor must humanize his knowledge. This involves working over subject-matter (which has been *arranged and classified in the interests of a specialist*) so that it matches the interests and needs of the college freshman or sophomore. To a teacher's knowledge of subject-matter must accordingly be added a sympathetic appreciation and understanding of the learner's background and *the ways in which his mind works*. Courses which adequately prepare teachers for this purpose are, therefore, neither content courses nor method courses as such, ... and are necessary so long as pupils remain in a state of intellectual dependence. The present trend in educational organization indicates that this state persists till about the end of the sophomore year.

Both teaching and research are legitimate activities and should be placed upon a basis of equality. If this is to be the case, professional preparation for teaching will have to become a function of Universities. (Already the School of Education at New York University and other institutions have accepted, in part, this principle.—Note by abstractor.)

Professor Thayer outlines a three-fold program: (1) The tangible encouragement of good teaching, (2) some degree of professional training as an initial requirement for teaching in college or university, (3) organization of departmental instruction so as to stimulate the interest of the faculty in the *scientific* study of teaching and the improvement of teaching method.

1—*Encouragement of good teaching:* No training in technic will bring forth fruits unless both spiritual and material influences coöperate to give significance to the practice of teaching. In university and college circles there exists a fairly widespread indifference, if not pessimism, regarding teaching.

The most obvious direct encouragement is the tangible recognition which presidents and deans and heads of departments must give to demonstrated teaching ability. The present feeling that promotion and recognition are accorded research activities in preference to teaching must be corrected. The fallacy in the present tendency to reward research lies in the assumption that all men must drink from the same fountain in order to retain an intellectual and spiritual vigor.

2—*Professional training as a prerequisite for teaching should include:* (*a*) Graduate courses on methods of organizing and teaching freshman and sophomore subjects; (*b*) practice in teaching under departmental supervision (*e. g.*, organization of quiz sections along these lines); (*c*) a . . . . . course or courses dealing with both general educational theory and method and the psychology of college students. This course in psychology should concern itself with *more than the conventional intellectual traits*. The aim should be to enable the young instructor to see his students as human personalities, to give him a sympathetic insight into problems of adjustment peculiar to students and an understanding of the interests and forces influencing their behavior.

3—*Training college teachers already in service:* It is a common observation at present that college teachers are predominantly specialists rather than the cultivated products of a liberal education. It is in the preliminary education of the prospective teacher and not in a dependence upon a system of supervision that we must look for assurance as regards his continuous growth.

Nevertheless, something can be done in existing faculties by means of group conferences, not merely as at present of instructors teaching parallel sections—these being no more than clearing houses for routine and clerical details—but rather by seminars on teaching method.

Teacher training for universities will shortly call for a specialized procedure which can be secured only from those who are definitely trained in their fields.

D. L. W.

Wanted, New Bottles for Old Wine. R. H. ADAMS. *J. Fla. Educ. Assoc.*, **5**, 5-6 (1928).—"The experiment of putting the wine of a new spirit into the bottles of old forms and formulas is not more likely to succeed in education than in other realms of human thought. New wine must be put into new bottles, else the 'new wine will burst the bottles and be spilled.'" The author, in a brief but thought-provoking article, sets forth the need for a new method of grading to meet modern needs. "Is education so esoteric, so intangible a thing, as to be incapable of being analyzed into identifiable terms?" he inquires. As long as teachers are required or expected to give grades to pupils on a percentage or percentage-equivalent basis, so long will they, their pupils, patrons, and the general public, continue to identify task performance with education. A new spirit has come into education. Let us have a new form of grading to express it.

A. P. B.

Harvard Coöperates with Pathé in a Series of Scientific Films. *Educ. Screen*, **6**,

485 (1927).—Impetus is given to the use of motion pictures in the teaching of scientific subjects by the recent announcement that Harvard University has entered into a five-year contract with Pathé, Inc., for the production of two series of scientific films. One series will be produced for use by colleges and universities; the other for grade and high schools. The departments of anthropology and geology will coöperate with the producers in the selection of material for the series from the vast film library of Pathé. Graduate students will cut, assemble, and title the film. A. P. B.

Studies on Gossypol. E. P. CLARK. *J. Biol. Chem.*, **75,** 725–41 (1927).—Gossypol, peculiar phenolic body present in cottonseed, which may have a very injurious and toxic effect upon livestock, has been separated in a state of analytical purity by the author. Its formula is shown to be $C_{30}H_{30}O_8$. Methods of separation, purification, and analysis of this interesting new compound are given together with the results of tests of toxicity on rats. A. P. B.

Improved Lighting Source for Melting-Point Apparatus. E. V. FASCE. *J. Am. Chem. Soc.*, **50,** 252–3 (1928).—A melting-point determination taken on a dull day or at night is both difficult to accomplish and a strain on the eyes. A light placed behind or above the apparatus is so reflected that little reaches the desired point. An apparatus is described which may be constructed cheaply from ordinary material available in any laboratory and which gives excellent results. A small box, of wood or aluminum, holds a 100-watt light bulb. In the wall opposite the bulb is a hole through which a piece of 8 mm. quartz tube is projected. The box is so placed that the beam of intense light coming through the end of the quartz tube falls on the melting-point tube. The point may be easily observed and little or no light is directed at the eyes of the observer.
A. P. B.

Supervision in the High School. B. F. QUIGG. *H. S. Quart.*, **16,** 90–4 (Jan., 1928).—We are endeavoring now to adapt the school to the child rather than the child to the school. There is a vast increase in high-school attendance. Many of the new teachers are inexperienced. They mean well, but many of them, except for a short course at college in educational psychology and the history of education, are for the most part unprepared and unfitted to give proper instruction in high school. For improvement in instruction it is necessary to improve the teaching force, and that means improvement in supervision. What is the superintendent going to do about his problem of the teacher and his supervision? Provided he has the time to visit the classroom, what is he going to do when he is there? Quigg quotes Anderson on seventeen things to do when the supervisor reaches the classroom. Quigg states and supports other things for the superintendent to do besides visit the classroom in his business of supervision. He then quotes and explains twelve phases of supervision which have impressed him in his personal experience and observation. J. H. G.

Curriculum Construction and Administration. A COMMITTEE REPORT. *H. S. Quart.*, **16,** 125–42 (Jan., 1928).—Curriculum construction is engrossing the attention of many in America. Curriculum is defined. Its development in typical high schools is explained at length. It is the expressed purpose of the curriculum policy herein defined to imply guidance in curriculum differentiation, and to prevent the crystallizing in the mind of the adviser of some unreasoned, fixed, and inflexible habit of making student programs. The Junior-Senior H. S. (6–3–3 or any other) plan of rearranging the grades of education may be safely said to be that of curriculum differentiation. Plans for Senior and Junior H. S. curricula follow. It is recommended that secondary schools admit and provide special instruction for all pupils who are in any respect so mature that they do not derive adequate benefit from the elementary school.
J. H. G.

An Adventure in Common-Sense Education. H. HOLT. *World's Work*, **55,** 421–6 (Feb., 1928).—Holt, as president of Rollins College, Florida, states that he is trying to make a college that does not confuse greatness with bigness. The three things that make a college great are: quality of those who teach; quality of those who are taught; quality of the grounds, buildings, and equipment. The aim is to perfect and dignify the small college. Students are limited to 400 male and 300 female. Having decided on a small college, the next step is to make it ideal. Environment has much to do with this, and the college as an environment ought to exert a maximum influence on a boy's or girl's life at the most plastic period of post-adolescence. There is the personal environment, the professors and students; and the impersonal environment, the ground, buildings, etc. It is the professors who make a college great. How rare is the great teacher! Visits to American colleges and universities have revealed that each one has one or two, rarely three great teachers. The teacher-professors, those who give attention to the teaching, are those who are rarely given a call to other places. These are the

rare souls who make the lasting impressions on the students. Rollins College invites only those teachers who are inspiring students and it intends to pay them well. Rollins is admitting any student above the intelligence of a moron and mature enough to carry on college work. Rollins has abolished the lecture and recitation system, which is probably the worst system ever devised for imparting knowledge, and has substituted the *two-hour conference plan.* The purpose underlying the two-hour plan is to bring the student and the professor into the closest possible touch during the working hours of the day. As a corollary to the two-hour plan, Rollins has abolished all cuts and all compulsory attendance at classes and chapel. Students are put on a par with employees in an office. A statement recently signed by twenty-two college presidents declared that the greatest weakness of the modern college is that it has failed to bring inspiration to its students or encouragement to scholarship. J. H. G.

The Broadening of the Outlook in Education. THE DUCHESS OF ATHOLL. *Sch. and Soc.*, **26**, 313–22 (Sept. 10, 1927).—An address by the President of the Educational Science Section of the British Assoc. for the Advancement of Science at Leeds, Sept., 1927. The education of the adolescent has much to do with present-day social and economic factors, and because this type of education is intimately connected with "The Broadening of the Outlook in Education" the writer considers it worth some attention. The various recommendations of the Board of Education's Consultative Committee in a recent report on the education of the adolescent are discussed. A brief history of education is given, passing from the purposes of the Cathedral schools of the Middle Ages to the Academies of France, where modern languages, mathematics, and some science were added to the study of the classics; then on to Scotland where fairly modern academies sprang into existence in the middle of the 18th century, and thence to the claims of the English.

A report by the Committee in 1912 criticized the aims of secondary education and recommended that some branches of educational handwork be taught. Despite various attempts to improve the curriculum it still remains somewhat unsatisfactory, a relatively small percentage of the pupils going on into the higher schools. Educated along academic lines, the need for practical instruction has been neglected and the organization of secondary education on a national basis has been slow.

The Duchess of Atholl makes a plea for the inclusion of vocational subjects in the British secondary schools, feeling that too much stress has been placed on the necessity of university education for all students. Manual training, domestic science, and allied subjects would better fit many of the students for life than does the regular secondary curriculum in existence at present. The various arguments to prove the value of this training are pertinent and well put. K. S. H.

Freedom in Education. LUCY L. W. WILSON. *The Survey*, **59**, 88–90 (Oct. 15, 1927).—The writer expresses, in this article, her impressions of the fourth international conference of the New Education Fellowship at Locarno last August, where over 1000 delegates from various parts of the world discussed "The True Meaning of Freedom in Education."

Pierre Bovet, director of the International Bureau of Education, the three founders of the league, and ministers of education from various countries were among the outstanding personalities at this Conference. The desire of this Fellowship has been to unite more firmly teachers, the world over, who have the same ideas and aims, and to keep alive the enthusiasm which is the product of these meetings. K. S. H.

A System of Note-Taking. G. W. ESTABROOKS. *Sch. and Soc.*, **26**, 715–7 (Dec. 3, 1927).—No satisfactory substitute having as yet been found, examinations still hold sway as a means of determining one's abilities and capacities. As a result, the student is expected to know certain things he is capable of understanding, and so the author attempts to set forth certain constructive suggestions on note-taking.

He advocates the keeping of two sets of notes: First, a loose-leaf notebook in which is jotted down everything of interest which the professor has happened to touch upon. Second, on three-by-five cards is kept a system of pocket notes—notes obtained by sorting out the material in a lecture—the really troublesome facts, definitions, etc. These cards serve as a sort of review and can be used to advantage during odd and ordinarily wasted moments.

The work must be systematized for the best possible results. A certain number of the cards should be reviewed each day and, in this way, the student is able to keep brushed up. Arrangement of the cards according to the difficulty of the material is another essential feature. Such facts as repeatedly escape one's mind should be entered upon a second, a third, and even a fourth card, that they may constantly appear. A final review of the cards just preceding an examination should be accompanied by a

review of the larger and more complete set of notes. "It should be a review of work thoroughly in hand and not a last-minute cramming to pass an examination."

K. S. H.

The Aims of a Liberal College. A. S. PEASE. *Sch. and Soc.*, **26,** 695–705 (Dec. 3, 1927).—In his inaugural address as President of Amherst, Dr. Pease states that the aims of education are: First, to prepare for one's life work; second, to furnish avocations that will round out and broaden life; and third, to enable one to assume a helpful place in his community. There are certain great leaders who have risen to heights without much in the way of a formal education, but the average man finds that the viewpoint acquired through education gives him an advantage over his untrained fellows.

Too much stress seems to be placed upon professional subjects in present-day education. The whole curriculum needs a revision with much pruning. It is most important that students be trained for independent thought and action—that they make critical appraisal of facts learned, and really advance in their studies. K. S. H.

Cheating in College. E. K. HILLBRAND. *Sch. and Soc.*, **26,** 748–50 (Dec. 10, 1927).—A definition of dishonesty, as applied to examinations, is followed by a discussion of various methods of dealing with cases of cheating. The instructor may deal with the cases individually, or he may refer them to the dean of the college or to a committee. In many institutions such cases are reported to a student council or senate, or, if the honor system prevails, to an honor court or council, which on the whole is not satisfactory.

The penalties inflicted are discussed at length, the degrees of severity varying in different colleges. The usual punishment for a first offense on a final examination, however, appears to be suspension or failure. It is felt by some progressive administrators that the less a student is supervised and watched over, the greater the impression on his part that the instructor has unshaken confidence in him.

One of the main causes of cribbing, as set forth by deans of different institutions, is the fact that many of the students come from high schools where cheating is tolerated, *i. e.*, where little or nothing is said concerning it and less done to curb it. Naturally, by the time such students get to college, their sense of honesty has become somewhat perverted.

However, replies received from deans in twenty-five North Central Association Colleges indicate that, on the whole, there has been a gradual decline of cheating during the last few years. K. S. H.

The Predictive Value of the Iowa Physics Aptitude Placement Test. ROBERT M. BEAR. *J. Appl. Psych.*, **11,** 381–4 (Oct., 1927).—This experiment grew out of a desire to find a means of determining the probable success of a student taking physics through the use of aptitude tests given at the beginning of the physics course. The author used 38 freshmen who were beginning the study of physics at Centre College, Kentucky, as case studies. The Iowa Physics Aptitude Test was given at the beginning of the school year and the scores made on this test were correlated with the first semester physics grade, the year grade made in physics, and with the average academic grade in all subjects. The correlations obtained were, respectively: 0.50 ± 0.08; 0.25 ± 0.10; and 0.64 ± 0.06. The author stated as his conclusion that the marks made on the Iowa Physics Aptitude Test were of slight value in predicting the probable success in physics of a student about to begin the course. S. R. P.

Subsequent History of E—: Ten Years after the Initial Report. LETA S. HOLLINGSWORTH. *J. Appl. Psych.*, **11,** 385–90 (Oct., 1927).—This is the third report made by the author of a case study (covering 10 years) of a boy having a very high I. Q. In 1917 E— had an I. Q. of 187 (as measured by the Stanford-Binet Test) and was doing superior work in the sixth grade of the Horace Mann School. At this time he was above average in height (54.3 inches) and also in weight (89.3 pounds). In September, 1921, measurements gave an I. Q. of 194 (Army Alpha Form 5). E— was then in the fourth semester of college and had a height of 64.2 inches and a weight of 166 pounds. In 1927 he made 441 points on the I. E. R. Intelligence Scale *C A V D.* (The score of the average adult is not yet known, but the medium score of college graduates in professional schools of first rate standards is 415 points, with an Upper Q at 421 points. The best score yet made by college graduates is about 440 points.) The score 441 points is $\pm$ 4.3 P. E. in relation to college graduates previously tested who were all above 20 years of age—many over 30 years of age. E— was 18 years and 9 months old when he took the test, weighed 194.75 pounds and had a height of 73 inches. E— obtained an M.A. degree from Columbia University in 1924 (making Phi Beta Kappa and many other honors) and has now practically completed requirements for the Ph.D. degree. S. R. P.

Experiment in Classifying High-School Pupils on the Basis of Achievement. HOMER P. RAINEY AND HILMA ANDERSON. *Educ. Admin. and Superv.*, **13**, 528–44 (Nov., 1927).—This article is a resumé of a study conducted in the Lincoln High School of Portland, Oregon, beginning in the spring of 1924 and continuing until January, 1926. Students were classified according to academic grades. A group of 400 pupils was studied intensively to determine: (1) The relationship between scores on intelligence tests and academic grades; and (2) the amount of material gain accomplished as measured by the elimination of failures and the improvement of grades. The correlation between scores on intelligence tests and grades was not high. Failures were reduced, but there was no improvement in the average grades. The plan proved to be very successful and the author commends its use in large high schools. S. R. P.

Experimental Data on the Purdue Rating Scale for Instructors. H. H. REMMERS AND G. C. BRANDENBURG. *Educ. Admin. and Superv.*, **13**, 519–27 (Nov., 1927).—Students at Purdue University, using the authors' rating scale for instructors, were asked to rate instructors on nine points: (1) Interest in subject, (2) sympathetic attitude, (3) fairness in grading, (4) liberal and progressive attitude, (5) presentation of subject, (6) sense of proportion and humor, (7) personal peculiarities, (8) personal appearance, (9) stimulating intellectual curiosity. A few days later the same students rate the same instructors on the same traits, but the rating scale values were changed—*e. g.*, what had been the 100 per cent end of the scale now became the zero end in the second test. The correlations were all positive and fairly high. Students seemed to be able to discriminate successfully among various traits for the same instructor and among different instructors for the same trait. S. R. P.

A Comparison of the Time Allotment of Subjects in Elementary Training Schools and in Elementary Public Schools. W. D. ARMENTROUT. *Educ. Admin. and Superv.*, **13**, 625–7 (Dec., 1927).—This study is based on replies to a questionnaire sent to training schools and public schools, 33 of the former replying and 49 of the latter. The total time in the elementary public schools is 8637 minutes per week compared with 7850 minutes in the elementary training schools. The training schools spend more time than the public schools on the following subjects: hygiene, history, music, industrial arts, penmanship, and supervised play. A wide variation in time given to a particular subject is quite characteristic. In reading, the time ranged from 85 minutes per week to 600 minutes, with an average of 346 minutes. Average number of minutes per week:

		Grades						
		1	2	3	4	5	6	Total
Geography	49 cities	11	14	59	137	156	162	539
	33 training schools	4	8	41	117	143	149	462
Science	49 cities	22	23	23	23	21	21	133
	33 training schools	15	10	19	17	14	11	86
Hygiene	49 cities	16	16	18	22	27	27	126
	33 training schools	17	31	35	46	56	58	243

Seventeen subjects were listed, science ranking sixteenth and civics last. Geography ranked seventh and hygiene ranked fifteenth. Combinations often found were: (1) Nature study and geography; (2) geography, history, and civics; (3) science, geography, and hygiene; (4) science, geography, and civics; and (5) science and hygiene. S. R. P.

Seeing Other Schools at Work. H. C. DENT. *Educ. Outlook* (British), **79**, 419 (Dec., 1927).—Advantages to be gained from visiting other schools while they are at work are discussed. Visiting other schools is both delightful and instructive to teachers, whether young or old, experienced or inexperienced, or on elementary, secondary, or college level. Teachers need to do more visiting than they do. Extensive reading about a particular method of instruction (Dalton plan or Montessori plan, for example) is far less valuable than a day's visit to one of these schools. The interchange of ideas, the renewal of courage and enthusiasm, the new stimulation to "carry on" and "do better" are invaluable outcomes. S. R. P.

Science in Education. H. H. VANNORSDALL. *Ohio Teacher*, **48**, 115 (Nov., 1927).—Although we are living in an age of revolutionary changes brought about chiefly by the discoveries and inventions of science, the methods of science have not been applied to education. The methods of teaching are not scientific; the curriculum has not been constructed scientifically; the teachers are not scientific in arriving at conclusions; and the measurements of results of instruction are very inaccurately made. The author briefly traces the history of science and shows that scientific methods have only been

used in the science field itself a comparatively short time. The development of a science of education is not a hopeless task, once the teachers wholeheartedly attempt it.
S. R. P.

Technical Terminology of Textbooks in Secondary School Science. S. R. POWERS. *Teachers J. and Abst.*, **2**, 625–8 (Nov., 1927).—This is the resumé of an objective determination of the technical vocabulary of textbooks in secondary school science. Thorndike's list of the 10,000 most important words was used as the criterion for selection of uncommon terms. Words not found in the Thorndike list constitute the author's list of technical terms. The author examined textbooks in biology, general sciences, physics, chemistry, and some popular scientific books and magazine articles. The reading material composed about 2,000,000 running words. The list of uncommon terminology from all sources included about 8000 terms, distributed as follows: General science 1404; biology 3956; chemistry 1973; physics 1320; popular scientific books and magazine articles 3602. Approximately 35 per cent of the words occurred with but a single frequency. A list of most "important" words, based on frequency of use, are distributed as follows: General science 812; biology 1309; chemistry 793; physics 713; popular scientific books and magazine articles 1191. About 77 per cent of the list of words found cannot be listed as important by the criterion used. Biology texts have the largest vocabulary of uncommon terms. Undoubtedly, the vocabulary burden for pupils studying science has been and is much greater than has been realized. Textbook writers and teachers of science should be more sensitive to this issue, so that in their writing and teaching they can face the issue intelligently. (A list of these terms is published in the Teachers College Record for November, 1926.) S. R. P.

Classical Origins of Scientific Terms. GONZALEZ LODGE. *Latin Notes Suppl.* (Service Bureau for Classical Teachers, Teachers College), Nov., **1927**, pp. 1–18.—This study should be of interest and value to teachers of science in as much as it furnishes more proof than is usually available of the dependence of science upon Greek and Latin for much of its vocabulary. The author used the list of technical terms published in the Teachers College Record for November, 1926, in an article by S. R. Powers entitled "A Vocabulary of Scientific Terms for High-School Students." In addition to this list, scientific words included in the Thorndike list of the 10,000 most common words are included. As a rule only Greek and Latin origins are given. The meanings of original words are usually, but not always, given. S. R. P.

Criticism of Modern Colleges and Universities. JOHN W. CRIST. *Educ. Admin. and Superv.*, **14**, 52–60 (Jan., 1928).—American institutions of higher learning are under the fire of considerable public criticism. Although these attacks have taken the outward forms of an anti-evolution campaign, a protest against student morals and charges of the encouragement of bolshevistic tendencies, the real causes for these criticisms are much more fundamental. The method of determining the eligibility of young men and women for matriculation in college (almost entirely high-school graduation) has crowded the universities and colleges with youths so immature in thought and experience that they are unable to weather the storms and make safe passage through the maze of our modern assemblage of real and hypothetical knowledge. The author quotes Henry Fairfield Osborn to the effect that "our intellectual environment (in college) would be distinctly against a young Darwin today." Two remedies, among many others, have been suggested. One attempts to adjust the subject-matter to the students' mentality, either by more or less extreme simplification, or by selecting and maintaining special faculties for underclassmen. The second remedy tries to eliminate from the libraries subject-matter which is supposed to create disturbance. Both methods have been failures. The author suggests the refusing of schools of higher education to young aspirants until such time as they are somewhat older in years and better tempered, have mentalities more capable of comprehension, and the construction of a sound and adequate philosophy of life. S. R. P.

The Thermometer and School. T. D. WOOD AND E. M. HENDRIKSEN. *J. Nat. Ed. Assoc.*, **16**, 258 (Nov., 1927).—A cool room, air currents, and humidity are the three main factors in ventilation. During winter weather the school room should have a lower temperature than in summer, in order to lessen the contrast in temperature between the school room heat and the outside cold. Hourly temperature charts are helpful. A. E. C.

Vat Colors. W. M. SCOTT. *Dyestuffs*, **28**, 177–85 (Dec., 1927).—There is given a brief history of Tyrian blue and indigo from ancient fable to modern manufacture. Followed by a discussion of indigoids and anthraquinone derivatives, improvements in the application of these colors to the fiber, modern formulas, and fastness characteristics. Twelve references. A. E. C.

Local Activities and Opportunities

Ohio S. C. T. A. The annual meeting of the Ohio State Chemistry Teachers' Association will be held in Columbus on Friday, April 13th, in conjunction with the meetings of the Ohio State Educational Conference. The chemistry group will meet for a luncheon and business session Friday noon, April 13th, and several five-minute talks will be given, followed by a discussion period. The Executive Committee will assemble on Thursday evening, April 12th, at the Faculty Club, for an important meeting.

Lexington Section, A. C. S. The 125th regular meeting of the Lexington Section of the American Chemical Society was held at the University of Kentucky, Tuesday, February 14, 1928.

Dr. R. I. Rush, head of the department of chemistry of Centre College, Danville, Ky., spoke on "Structural Changes in Amorphous Materials. Silica Gel."

The talk concerned itself with structural changes taking place when a silica gel is heated, and with the commercial uses of silica gels.

Dr. Rush has recently joined our local section, coming to us from Bristol, Va.

Cincinnati Section, A. C. S. The 296th regular meeting of the Cincinnati Section of the American Chemical Society was held in the Chemical Auditorium of the University of Cincinnati, on Wednesday, February 15th, at 8 o'clock.

The program of the evening was a pageant under the title of "A Night in Alchemy." It was presented by Mr. R. D. Billinger, assisted by Messrs. Edward Schlesselman and Lester German, all of the chemistry department of the University of Cincinnati.

The spectacle was staged to represent an alchemical laboratory with appropriate setting including apparatus, lights, costumes, etc. A discourse on the art of Alchemy was given and profusely illustrated by spectacular experiments.

The University of Chicago. Professor Stieglitz attended the meeting of the special committee appointed by the U. S. Civil-Service Commission to pass on the applications for appointment of a professor of chemistry of the U. S. Public Health Service. The meeting was held on February 4th, in Washington.

Florida Section, A. C. S. The Florida Section of the A. C. S. held its 17th meeting in the assembly hall of Southern College, Lakeland, Fla., on Saturday afternoon and evening, Feb. 25th. The program took the form of a phosphate symposium, with the following speakers:

"The Production of Phosphate Rock and Its Control by the Laboratory," E. T. Casler, Phosphate Mining Co., Nicholas, Fla.

"Composition of Phosphate Rock and Methods of Analysis," R. P. Thornton, Wood-Thornton Laboratories, Tampa, Fla.

"Economic Production and Conservation of Phosphates," A. L. Kriess, Kriess Potassium Phosphate Company, Tampa, Fla.

"Utilization of Low-Grade Phosphate Rock," A. S. Almy, Zeltrocide Chemical Company, Lakeland, Fla.

"Some Remarks on the Manufacture and Chemistry of Portland Cement," S. Rordam, Florida Portland Cement Co., Tampa, Fla.

Between the afternoon and evening sessions a dinner was held in the main dining room of the college.

University of Florida. Mr. J. M. Boyd, B.S. Ch.E., University of Florida, 1926, and at present an instructor in Physics here, has accepted a graduate assistant-

ship at the University of Pittsburgh, where he will work toward his Ph.D.

Applications will be received until May 15th for four University Fellowships in Chemistry at the University of Florida. These fellowships pay $500.00 per year. Holders of the fellowships are expected to devote not more than 12 hours per week to laboratory instruction in elementary courses. The Master's degree may be taken in a year and one summer. Applications should be addressed to Dr. T. R. Leigh, Head, Department of Chemistry, U. of Florida, Gainesville, Fla., and should be accompanied by complete transcript of credit and names of at least two references.

Curator B. J. Otte has just returned from Savannah, Ga., where he attended the fifth annual Naval Stores Get-Together, Feb. 20th to 22nd.

Some prominent speakers and their subjects were:

"Research in the Naval Stores Industry," Dr. C. H. Herty.

"Industrial and Agricultural Future of the Southwest," Dr. W. J. Hale.

"Research Progress of the Pine Institute of America at Mellon Institute," Dr. George D. Beal.

"Coöperation of the U. S. Department of Chemistry with the P. I. A.," Dr. F. P. Veitch.

"Microscopic Work on the Chips of the Pine Tree," Dr. Eloise Gerry, Forest Products Laboratories, Madison, Wis.

Cornell University. The department of chemistry at Cornell will offer instruction in chemical microscopy during the coming Summer Session of the University. The equipment of the Baker Laboratory is unique in this field and affords excellent facilities for study of the various microscopic methods applicable to chemical problems.

The introductory course will cover the use of the microscope and its accessories, microscopic measurements and quantitative methods, crystal studies and physicochemical phenomena, refractive index determinations, and examination of textile and paper fibers. A course in microscopic qualitative analysis, including the reactions of the commoner metals and acids, will also be given. Both of these courses will be the full equivalent of those given during the regular college year; they may be taken separately or together, or other work in the department may be carried on, according to the needs of the student.

The Summer Session opens July 2nd and continues for six weeks, but persons not desiring University credit may arrange to cover, in a shorter period, those portions of the work most suited to their special needs. Any inquiries should be addressed to Prof. C. W. Mason who will have charge of the courses.

Illinois. Oak Park High School of Oak Park, Illinois, will hold an open house and chemistry exhibit on the night of March 23rd. Seventy pupils are working on as many different projects. A cordial invitation is extended to all—especially to teachers who may be interested in the arrangement of such exhibits.

New York University. Dr. James Kendall who has been dean of the Graduate School since March, 1927, will, at the end of the academic year, leave to accept the Chair of Chemistry made vacant by the retirement of Sir James Walker of Edinburgh.

Recent Books

The Mechanism of Homogeneous Organic Reactions from the Physical-Chemical Standpoint. FRANCIS OWEN RICE. Associate Professor of Chemistry in the Johns Hopkins University. First edition. The Chemical Catalog Company, Inc., 419 Fourth Avenue, at 29th Street, New York, U. S. A., 1928. v + 211 pp. 12 figures and 26 tables. 15 × 22.5 cm. $5.00.

This book is No. 39 in the American Chemical Society Monograph Series. It is a comprehensive treatment of the reaction kinetics of homogeneous organic reactions. Its purpose can best be stated in the words of the author: "Reaction kinetics provide us with a powerful weapon for investigating the mechanism of organic reactions and has been freely used for this purpose in nearly all investigations concerning the mechanism of organic reactions. It, therefore, appeared desirable to make a systematic study of homogeneous organic reactions from this point of view, so that the information available would be collected and presented in a more accessible form than scattered through the literature."

The author first takes up the theory of reaction velocity, discussing the derivation of formulas to express the rates of reaction in simultaneous, opposing, consecutive, and side reactions. He then reviews methods of analysis, errors in measurement, and effect of temperature.

Chapter II is a section devoted to the discussion of addition compounds. Their existence, measurement, and dependence upon the chemical constitution of the components is first taken up, followed by a discussion of their relation to ionization and catalytic activity.

Chapter IV entitled "Theoretical" is a presentation of the difficulties encountered in trying to formulate a theory of reaction velocity, followed by a review of the various theories which have been promulgated. These are arranged in the chronological order of their appearance and include the Arrhenius Hypothesis, Radiation Hypothesis, Skrabal's Hypothesis, the Activity Hypothesis, and the Dry Hydrogen-Ion Hypothesis.

The remainder of the book, consisting of six more chapters, takes up the mechanism of various organic reactions from the point of view of reaction kinetics. These are classified as follows: Chapter V, Isomeric Change, including a detailed account of keto-enol tautomerism and geometric isomerism; Chapter VI, Hydrolytic Reactions, including the hydrolysis of esters, lactones, acid anhydrides, amides, and the inversion of sucrose; Chapter VII, Aliphatic Hydrocarbons, the halogenation and oxidation of paraffins, and the reactions of the unsaturated hydrocarbons with halogen, halogen acid, nitric acid, etc. Chapter VIII, Reactions of Benzene Derivatives, including discussions of directive influence, effects of temperature, solvents, and catalysts, and the standard reactions of the benzene compounds. Chapter IX, General Reactions, reactions which cannot be classified in any of the above classes, such as Friedel and Crafts Reaction, Cannizzaro's Reaction, and the Claisen Condensation; Chapter X, Special Topics such as the Walden Inversion, the Beckmann Inversion, and Chemical Reactivity.

This book is valuable in that it is a logical development of the theory concerning reaction kinetics followed by practical applications to show what a powerful tool it is in the solving of certain types of problems in organic chemistry. It is further valuable in that it has accomplished one of its purposes in bringing together the widely scattered literature

on the subject in a form which is easily accessible.

ROBERT D. COGHILL

Avicennae de Congelatione et Conglutinatione Lapidum. Being sections of the Kitâb Al-Shifâ', the Latin and Arabic texts, edited with an English translation of the latter and with critical notes by E. J. HOLMYARD, M.A., M.Sc., F.I.C., M.R.A.S., head of the science department, Clifton College, Bristol, and D. C. MANDEVILLE, Clifton College. Librairie Orientaliste, Paul Guethner, Paris, 1927. x + 86 pp. 16.5 × 24.3 cm. 15 s.

In this book the authors settle a question which has for some time agitated students of the history of mediaeval science. They show that the *liber de mineralibus Aristotelis* (Aristotle's book on minerals) "is a translation—more or less satisfactory and not always complete—of passages occurring in Avicenna's great work *The Book of the Remedy*." A Latin translation from this Arabic work of Avicenna in the Middle Ages became combined with a Latin translation from the Greek of Aristotle's "Meteorology" and the whole soon passed as the work of Aristotle. The present book includes a mediaeval Latin version of that part of the work which was falsely ascribed to Aristotle, the Arabic text of the same from the *Kitâb al-Shifâ'* of *ibn Sina* (Avicenna), and an English translation of the Arabic text.

The chapters from the Shifâ' which are here at issue were written after 1021 A.D. and probably before 1023. The first, on the formation of stones, rocks, and mountains, is remarkable for its accurate insight into geological phenomena. The second, on the formation of minerals, is important to students of the history of chemistry, for it sets forth Avicenna's later and maturer views on alchemy. It contains a clear exposition of the sulfur-mercury doctrine of the composition of the metals—"that mercury, or something resembling it, is the essential constituent element of all the fusible bodies, for all of them are converted into mercury on fusion," and describes the metals in a manner later employed by the mediaeval Latins, which shows that Avicenna had genuine knowledge of their chemistry. The author is strong in his criticism of the alchemists and plain in his statement that the transmutation of the metals is impossible. Metals can be dyed, but their essential nature remains unchanged. He regards it as impossible to eliminate or to impart the specific differences which distinguish them.

Again we are grateful to Holmyard for giving us the benefit of his knowledge of Arabic.

TENNEY L. DAVIS

Quantitative Chemical Analysis. CHARLES M. ALLEN, M.A., head of department of chemistry, Pratt Institute, Brooklyn, N. Y. Second edition. John Wiley and Sons, N. Y. (Wiley Technical Series Loose-Leaf Laboratory Manual, J. M. Jameson, Editor), 1927. ii + 86 pp. 6 figures. 20.5 × 26.25 cm. $1.50 net.

This manual contains, first, a discussion of the usual general processes of Gravimetric Analysis, such as weighing, precipitation, washing, and ignition. Following this are representative gravimetric determinations: namely, complete analyses of barium chloride, magnesium sulfate, potash alum, and limestone. Under Volumetric Analysis is first given a discussion of general processes, volumetric measurements, standard and normal solutions and indicators. The volumetric analyses include standard acid and base, the normal acidimetric measurements, hardness of water, oxidation methods with dichromate and permanganate, chlorine in bleach, "oxidizing power" of pyrolusite, and a few iodometric measurements. Following each determination is a list of questions and problems "designed to prevent mere mechan-

ical performance in following the directions."

The methods are, in general, such as are usually covered in elementary analytical work, and the details of the procedures are accurate. In only one or two cases are there likely to be any criticisms. For example, the method used in determining non-carbonate hardness of water should be replaced by the better "soda reagent" method. Also the results would better be stated as "parts per million" instead of "parts per 100,000."

The weakest feature about the book is the absence of modern analytical theory. It does seem that one scarcely has the right to deny a student the real explanation of all the analytical processes, so far as such explanation is possible. Quantitative analysis offers a splendid opportunity to drive home the value and significance of the wonderful equilibrium relations found in precipitation and solution, in the color changes of indicators, and in oxidation-reduction reactions. The reviewer is also at a loss to know just why the book is constructed in loose-leaf form. It hardly seems possible to insert enough extra sheets to hold the necessary notes, etc.

In general, the book is good and, without a doubt, will give a student good training in beginning quantitative analysis.

W. H. CHAPIN

Physical Chemistry and Biophysics for Students of Biology and Medicine. MATTHEW STEEL, Ph.D., Professor of Biological Chemistry, The Long Island College Hospital. John Wiley & Sons, Inc., New York and London, 1928. x + 372 pp. 38 illustrations. 15 × 23 cm. Cloth, $4.00 net.

The author has selected from the large mass of physico-chemical data those which are most closely allied to biological processes. Knowledge of these fundamentals is essential to a better understanding of the physiology of animals and plants. Although the book is written primarily for the medical student it will be equally serviceable to students of other biological sciences. A glance through the table of contents clearly shows the author's care in the selection of subject-matter.

Fifty-eight pages of the book are devoted to the nature and structure of matter. Other topics considered are: general properties of matter; energy transformations in living matter; general nature of solutions; water, the greatest solvent; diffusion and osmotic pressure; the nature and behavior of electrolytes in solution; chemical equilibrium and the law of mass action; measurement of hydrogen-ion concentration; the colloidal state of matter; catalysis and velocity of chemical reactions; dynamical physical chemistry of the cell. More space (86 pages) is given to the discussion of colloids than to any of the other topics. Loeb's researches on proteins and the Donnan membrane equilibrium are included in this chapter. Both an author and a subject index are given.

The main discussions are developed historically. The student is led almost unconsciously to the modern viewpoints by a series of gradual and natural steps. Numerous and lengthy quotations appear in the body of the text. A book thus written has the advantage of placing the responsibility of statements on the authors quoted and in some cases the disadvantage of subjecting the reader to abrupt changes in style. A few defects have been noted. For example, figure 2 could be improved and made to agree with its description in the text. The subject of osmotic pressure is always an invitation for an argument especially when a statement (p. 131) like the following is given as a fact: "What is determined in the actual measurement of osmotic pressure is the force whereby the solute attempts to enter the solvent through a semi-permeable membrane." This is the diffusion pressure of the solute. Generally speaking, this confusion of

diffusion pressure and osmotic pressure is quite common.

The book supplies a much-felt need and will prove exceedingly useful to biological students.

EARL S. JOHNSTON

The Electronic Theory of Valency. N. V. SIDGWICK, M.A., Sc.D., D.Sc., F.R.S. Oxford University Press, American Branch, New York, 1927. xii + 310 pages. 4 figs. 24 × 16 cm. $5.00.

The book gives the fullest account yet available of the principles of valency and molecular constitution, based upon the Rutherford-Bohr atom. It attempts to interpret the fundamentals of valency in molecular structure in terms of the physical concepts of electrons, nuclei, and orbits, without transgressing the physical laws which these physical entities possess. The book, therefore, outlines the theory of the nuclear atom, the Bohr concept of the hydrogen atom, and the Bohr-Main, Smith-Stoner proposals for the position of orbital electrons in atoms. With this as a foundation it proceeds with the development of the electronic theory of valency, the familiar views of Kossel, Lewis and Langmuir constituting the fundamental basis of presentation. To the ideas of electrovalency and co-valency the concept of coördinate valency is added. Having discussed the criteria of each, the applicability to Werner's theory of coördination is illustrated in detail. The idea of a coördinate link with one atom or group as donor of electrons and one as acceptor constitutes a necessary amplification and extension of Werner's ideas to double salts and to chelate or ring compounds in which latter one part of the molecule acts as donor to another part as acceptor. Molecular association in compounds is attributed to coördinate linkages, as also is solvent power, hydrate formation, and solvation. Atomic and molecular magnetism are then treated, followed by a discussion of the stereochemistry of various elements in their compounds. A more detailed discussion of chelate rings is given and a final chapter is devoted to a skeleton outline of a future volume taking up the applicability of these ideas to the individual elements and their compounds.

The author has undoubtedly given us a most lucid treatment of the subject and has succeeded in systematizing, with the aid of a few electronic postulates, a vast mass of inorganic chemistry as well as organic. The book should be read by all teachers of chemistry. It is already being used with success in at least one university (Princeton) as an advanced text for graduate students in inorganic chemistry.

HUGH S. TAYLOR

The Higher Coal-Tar Hydrocarbons. ARTHUR ERNEST EVEREST. Longmans, Green and Co., Ltd., New York, 1927. xiii + 334 pp. 22 × 14 cm. $7.00.

As pointed out by the author, the field of coal-tar hydrocarbons is far too extensive to be dealt with in such a volume as this and so all hydrocarbons up to and including naphthalene and anthracene have been omitted. The author has collected and presented in a compact well-arranged form the known facts regarding the acenaphthene, fluorene, and phenanthrene groups of hydrocarbons, together with some miscellaneous groups not included under these headings. A great gain in clarity has been attained by the care taken with the numbering of the various ring complexes.

The number of suggestive things pointed out by the author are many and a few may be mentioned here. Speaking of pyrene, $C_{16}H_{10}$, the author states: "Despite the fact that this substance has been known for a considerable time—Laurent obtained it in an impure state in 1837—it has not yet attracted any great amount of attention, nor has it yet received any large technical application. Glaser has pointed out that this hydrocarbon contains a larger percentage

of carbon (95 per cent) than coal itself." Again we find that benzerythrene (4.4'-diphenyl-diphenyl) becomes "highly electrified when warmed." The author has done a great service in writing this book, covering a field which still in large measure awaits exploitation both scientifically and commercially.

F. O. RICE

Annual Survey of American Chemistry. Volume II. July 1, 1926–July 1, 1927. Edited by CLARENCE J. WEST under the auspices of the Division of Chemistry and Chemical Technology of the National Research Council. Published for the National Research Council by the Chemical Catalog Co., New York, 1927. 397 pp. 13 × 21 cm. $3.00.

It is a self-evident proposition that the rapidly increasing volume of chemical publications demands some sort of a resumé of literature that will aid the general student in gaining an accurate idea of the current advances in the various fields of pure and applied chemistry. American chemistry itself had seemingly reached this stage, and the reception of Volume I brought confirmatory evidence to the editors of the need and general desire for such a publication; hence, its continuation under the auspices of the National Research Council.

This survey (Volume II) is the work of 51 well-known chemists, 24 of whom edited the corresponding chapters in the first report. The book contains 49 chapters and 415 pages as against 34 chapters and 251 pages in Volume I. The additional 158 pages are largely due to the following additions:

(*a*) An increase in the space devoted to physical chemistry;

(*b*) Four chapters on analytical chemistry including the common and rare elements and micro-chemistry;

(*c*) The inclusion of additional reports on applied chemistry in the fields of glass, clay-products, coke, coal and gaseous fuels, petroleum chemistry and technology, rayon, leather, and the fixation of nitrogen.

(*d*) New chapters in electro-organic, stereo, and sugar chemistry.

(*e*) An author's index to volumes I and II.

The volume is primarily a report of progress, though in many cases especially important investigations are evaluated. It may be of interest to mention that under aliphatic compounds Dr. Reid has suggested some lines of needed research and has listed the institutions and the types of aliphatic compounds that are being investigated in their laboratories.

In the chapter on coöperative research, Dr. Hale has given the title "25 Investigations That Were in Progress in the Fall of 1926." This data affords some interesting information as to the types of problem that the industries feel are worth investigating and it should be of service in indicating to the isolated investigator this field of opportunity for coöperative work on worthwhile problems.

In short the staff of editors deserves commendation for its able and painstaking work in presenting to American chemists this convenient and noteworthy survey of the year's literature.

F. B. DAINS

TO BE REVIEWED LATER

General Chemistry—McCutcheon & Seltz.

Einfuhrung in die Mathematik fur Biologen und Chemiker—Michaelis.

Exercises in General Chemistry—Allen.

Laboratory Manual of Colloid Chemistry—Holmes.

Mathematical Preparation for Physical Chemistry—Daniels.

The Phase Rule and Its Application—Findlay.

Principles of Metallography—Williams & Homerberg.

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